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RESULTS OF ANALYSIS OF FLIGHT AND GROUND OBSERVATION MATERIALS FOR FIRST YEAR OF FIRST STAGE OF "PROGRAM OF EXPERIMENTAL RESEARCH TO DEVELOP METHODS FOR REMOTE SOUNDING OF SOILS AND VEGETATION ON ANALOGOUS SECTIONS OF THE UNITED STATES AND USSR FOR 1975-1980"

ACADEMY OF SCIENCES USSR

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16. Abstract

This is a report of a joint USSR and United States program to develop methods for remote sounding of soils and vegetation. The program is being conducted on similiar sections of land in the USSR and the United States during the period 1975-1980. Details of the data obtained and the type of sensing equipments employed are provided in the appendices.

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[MOSCOW, JULY 1977]

1.0. Tasks of the analysis /1*

1.1. Comparative evaluation of the reliability of recognition of the targets under study.

1.2. Determination of the most informative spectrum intervals.

1.3. Determination of the best time (season) for recognizing the targets under study.

1.4. Evaluation of the close correlation between the coefficients of spectrum intensity (CSI) determined by spectrometer and the optic densities of zonal aerial photographs (D).

1.5. Evaluation of the close correlation between optic densities of zonal aerial photographs on the one hand and the biomass of vegetation and surface moisture of soil on the other hand.

1.6. Specification of the composition and volume of observations for the next stage of the experiment.

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*Numbers in the margin indicate pagination in the original foreign text.

2.0. Initial data and materials /2

As a result of flight and ground experiments the following materials were obtained:

2.1. Aerial photographs of test sections by periods and spectrum channels indicated in table 1.

TABLE 1

Date	6.10.75	24.6.76	22.7.76	18.8.76	23.9.76
stage of winter wheat	sprouts	ear formation	lacteous ripeness	yellow ripeness	after harvest
spectrum channels (micrometer)	0.44-0.48 0.52-0.59 0.59-0.69 0.67-0.73 0.7-0.86	0.4-0.5 0.5-0.6 0.6-0.7 0.7-0.76	0.4-0.5 0.5-0.6 0.6-0.7 0.7-0.76	0.4-0.5 0.6-0.7 0.7-0.76	0.4-0.5 0.5-0.6 0.6-0.7 0.7-0.76

Appendix 1.

2.2. Coefficients of spectrum intensity, obtained as a result of spectrometering of the fields under study from the earth (6.7.75) and from a helicopter at altitude 100 m (22.6.76, 23.7.76, 9.9.76).

Appendix 2.

2.3. Data of ground observations: biological, soil, meteorological, recorded in the approved forms, by dates: 24.6.76, 21.7.76, 18.8.76, 17.9.76. /3

Appendix 3.

2.4. Ground photographs of targets under study.

Appendix 4.

2.5. Photographs of fields obtained synchronously with spectrometering.

In appendix 2.

2.6. Technique of biological measurements. Appendix 7.

2.7. Description of spectrometer. Appendix 8.

3.0. Preliminary processing of initial data /4

3.1. The "Joyce Loebb" microdensitometer was used to measure the optic densities (D) of images of the targets under study in all periods in all spectrum zones. The number of measurements at each target--50. From materials for 22.7.76 at each target 150 values of D each were measured.

The statistical characteristics were computed for the quantities of optic density--sampling averages (A) and standard deviations. Results of the calculations are tabulated. Appendix 5.

3.2. Computations were made of the sampling averages and standard deviations for coefficients of spectrum intensity for 10 points of each target for all dates of spectrometric observations. Graphs were drawn for the relationships between CSI and the effective wavelength. Appendix 2.

3.3. The average weight of dry biomass and the average leaf index were computed for each target for all observation dates.

Appendix 3.

4.0. Technique for analyzing comparative information content of spectrum channels for spectrum coefficient of intensity (CSI) and optic densities of zonal images (D) /5

The task of determining the information content of spectrum channels for recognizing the natural targets by density corresponds to the task of determining the usefulness of signs in the theory of form recognition. In our case the signs

are the reflecting powers of the targets in different spectrum zones, while the values of the signs are the CSI or D in the corresponding zones. Evaluation of the sign usefulness is made by the strictest method--calculation of entropy and information according to the formulas:

$$P(V_i/A_{jj_1}) = \frac{P(V_i)\, p\,(A_{jj_1}/V_i)}{\sum_{i=1}^{m} P(V_i)\, p\,(A_{jj_1}/V_i)} \qquad (1)$$

$$H(V/A_{jj_1}) = -\sum_{i=1}^{m} p(V_i/A_{jj_1}) \log_2 p(V_i/A_{jj_1}) \qquad (2)$$

$$H_K(V/A) = \sum_{jj_1=1}^{m} P(A_{jj_1})\, H(V/A_{jj_1}) \qquad (3)$$

$$P(A_{jj_1}) = \sum_{i=1}^{n} P(V_i)\, p\,(A_{jj_1}/V_i) \qquad (4)$$

Here: /6

$P(V_i/A_{jj_1})$ --a posteriori probability of the affiliation of the fundamental target (i.e., areas, orders of instantaneous field of vision of measuring instrument) to class V_i.

A--value of coefficient of spectrum intensity or optic density of image.

K--number of sign (spectrum zone).

n--number of classes.

m--number of intervals in range of measurements for values A.

$P(V_i)$--a priori probability of class V_i.

$P(A_{jj_1})$-- probability of quantity A appearing in interval jj_1.

$P(A_{jj_1}/V_i)$-- probability of values A of fundamental target falling in interval jj_1 on the condition that this target belongs to class V_i.

$H(V/A_{jj_1})$--entropy of experimental recognition on the condition of the appearance of target A_{jj_1}.

$H_K(V/A)$--complete entropy, mean for all values A_{jj_1}, with regard to

the probabilities of these values appearing.

These formulas were used to compute the entropy in the experimental recognition n of the objects according to sign K.

Besides determining the mean quantity of information for recognition of all the targets under study, calculations were made of the amounts of entropy in the experimental recognition of each of the n classes (i) on the background of all the remaining differences from class i which are viewed as one class. /7

These data make it possible to determine which signs and what time are the most optimal for recognizing certain classes of targets on the background of the remaining. The entropy of the experimental recognition of the assigned class of targets on the background of the remaining is determined according to the following formulas:

$$H(V_i/A_{jj_1}) = -P(V_i/A_{jj_1}) \log_2 P(V_i/A_{jj_1}) - \quad (6)$$
$$- [1 - P(V_i/A_{jj_1})] \log_2 [1 - P(V_i/A_{jj_1})]$$

$$H(V_i/A) = \sum_{jj_1=1}^{m} P(A_{jj_1}) H(V_i/A_{jj_1}) \quad (7)$$

Calculations according to formulas 1-7 were made on the ES-1030 Electronic Computer. The program of calculations is in appendix 6.

The calculations according to the formulas were made under the assumption that the distribution of variabilities of the quantities CSI and D conform to the normal law.

The conclusion that the distribution of probabilities of these amounts is close to the normal has been established by many researchers.

In addition, in order to substantiate this conclusion special studies were made on the materials from measurements of D on multizonal photographs.

The distributions of probabilities of quantities D were analyzed on aerial photographs in all zones on 22.07.76 for all the targets under study, except natural vegetation which was included in the group of targets for recognition.

Verification of the hypothesis on the normal distribution was made by Pearson's correlation coefficient with level of significance 0.05. The results of the computations are presented in table 2.

TABLE 2 /9

Zones / Targets	0.4-0.5 μm		0.5-0.6 μm		0.6-0.7 μm		0.7-0.76 μm	
	$X^2_в$	X^2	$X^2_в$	X^2	$X^2_в$	X^2	$X^2_в$	X^2
I--winter wheat	8.8	15.5	1.5	14.1	10.5	16.9	5.7	11.1
II--winter wheat	1.3	7.8	6.0	7.8	3.7	14.1	16.1	11.1
III--corn	2.1	14.1	5.8	11.1	10.4	14.1	6.1	14.1
IV--corn	0.9	3.8	6.5	14.1	9.5	7.8	9.4	9.5
V--spring wheat	1.4	6.0	9.3	14.1	8.7	11.1	5.8	16.9
VI--spring wheat	6.8	15.5	4.7	9.5	3.6	7.8	1.7	12.6
VII--clover	3.8	11.1	10.4	18.3	8.3	12.6	4.3	11.1
VIII--clover	6.2	7.8	1.5	9.5	0.6	6.0	23.1	9.5
IX--oak	8.6	9.5	15.8	16.9	10.6	11.1	3.5	14.1

Here $X^2_в$--computed quantity of correlation coefficient,

X^2--critical point of distribution of X^2.

The materials of table 2 indicate that in 96% of the cases the empirical data agree with the hypothesis on normal distribution. This number corresponds to the accepted level of significance 0.05.

5.0. Results of analysis of comparative information content of spectral channels and seasons for recognition of targets under study. /10

5.1. As initial data for calculating the quantities of entropy results were used from measurements of the optic densities of images and coefficients of spectrum intensity. The group of targets for recognition included the main targets of the central chernozem zone: winter wheat (II), spring wheat (V), corn (IV), clover (VII), woods (oak) (IX), and fallow land or plowing. Natural grasses were not included in the group for recognition, since they occupy a very

insignificant area (in preserves). Measurements of CSI and D of fallow land are not available for all the dates. However, this should not have a significant effect on the remaining results since fallow land is easily distinguished from the vegetation targets.

In certain cases large discrepancies were found between the sampling mean quantities of optic densities of analogous targets. This is explained by the effect of such factors as lodging, weediness, dispersity of the sowing, etc. For further processing, data were selected for those targets where the indicated factors were lacking or were present to a lesser degree.

The a priori probabilities of the targets were computed on the basis of published reference data on the percentage of areas occupied in the central chernozem zone by different types of vegetation. /11

Winter wheat--50%, spring wheat--15%, corn--10%, grass--10%, woods 5%, the rest--5%.

The calculated quantities of entropy are given in the tables, appendix 6. The interval borders of the spectrometer are somewhat arbitrary; they are given from the effective wavelength and average width of interval--0.02 μm. These data were used to construct graphs for the dependencies of entropy on the effective wavelength of the spectrum zone (fig. 1-3). On the basis of an analysis of the data in the appendix tables and graphs (fig. 1-3) the spectrum zones and seasons were ranked according to information content for recognition of the targets under study by coefficients of spectrum intensity or optic densities of the images.

The results from analysis of the information content are reflected in tables 3 and 4.

On the basis of these data a graphic idea was given for the optimal recognition of the targets under study at various times according to the two most informative zones in recognition by optic densities of images (fig. 4,5) and by

coefficients of spectrum intensity (fig. 6). The spread of quantities CSI and D on the borders is shown within the doubled quantity of standard deviation.

22 June 1976

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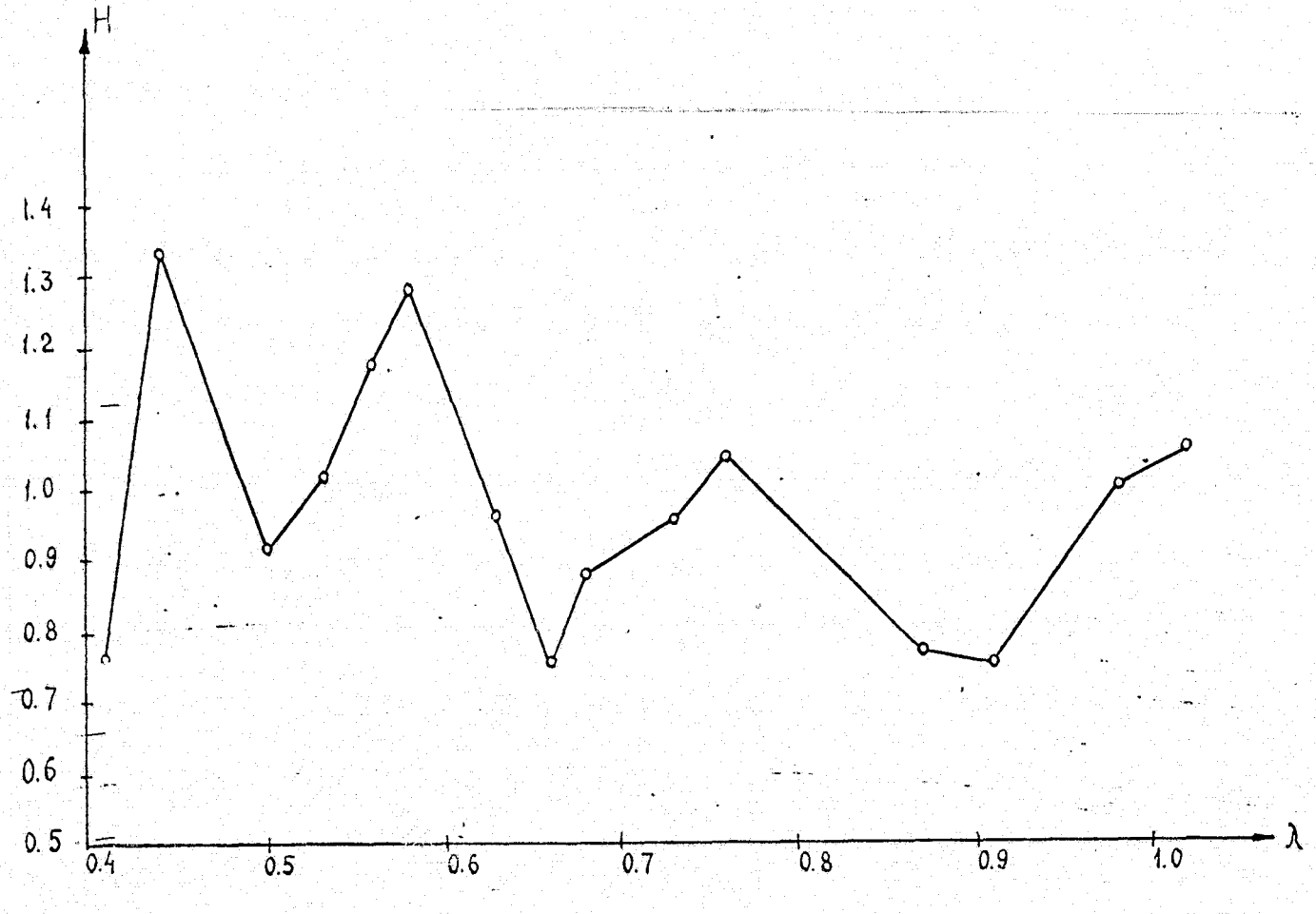


Figure 1. Dependence of Quantity of Average Entropy (H) on Effective Wavelength (λ) of Spectrum Zone in Recognition by CSI

9 September 1976

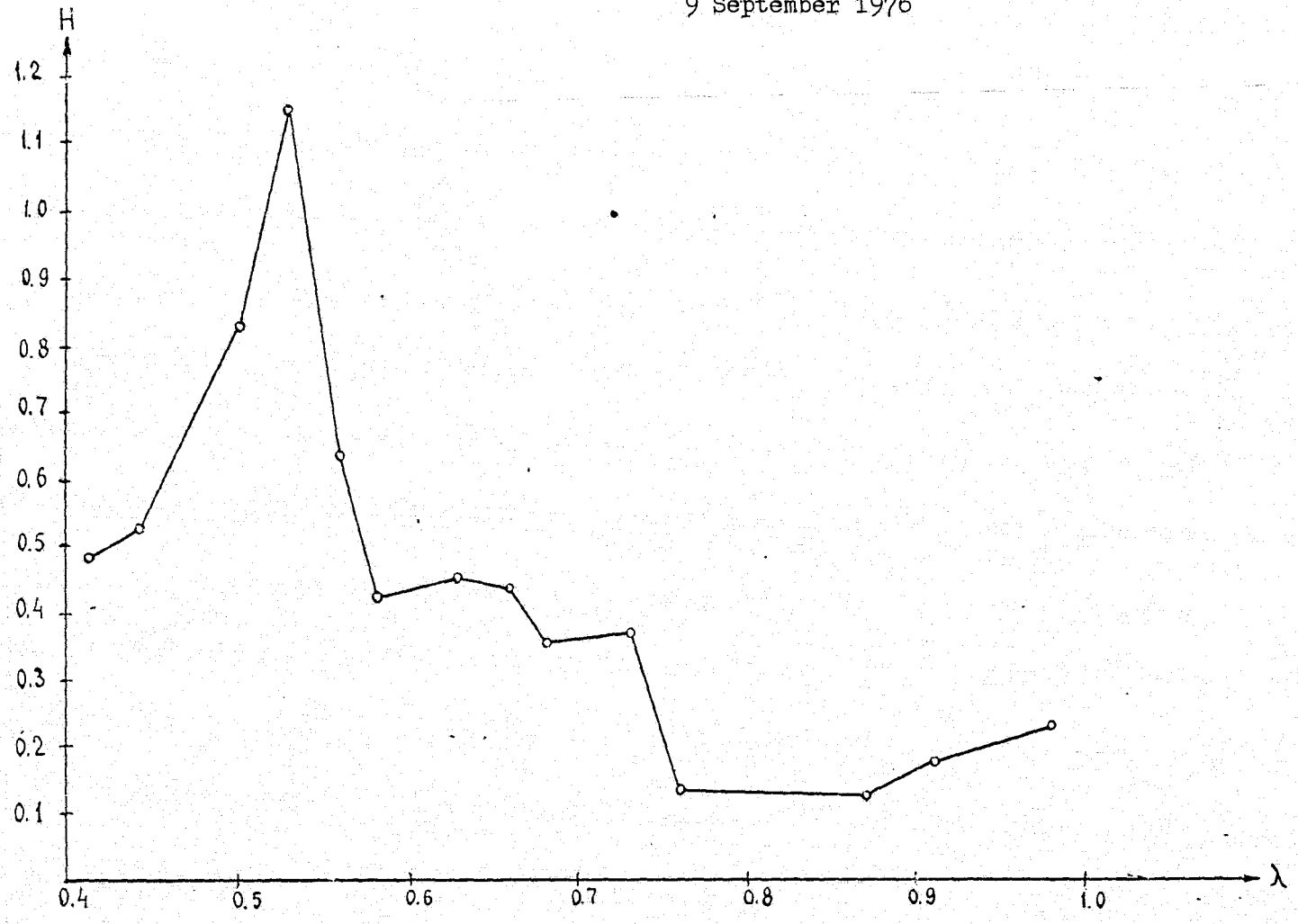
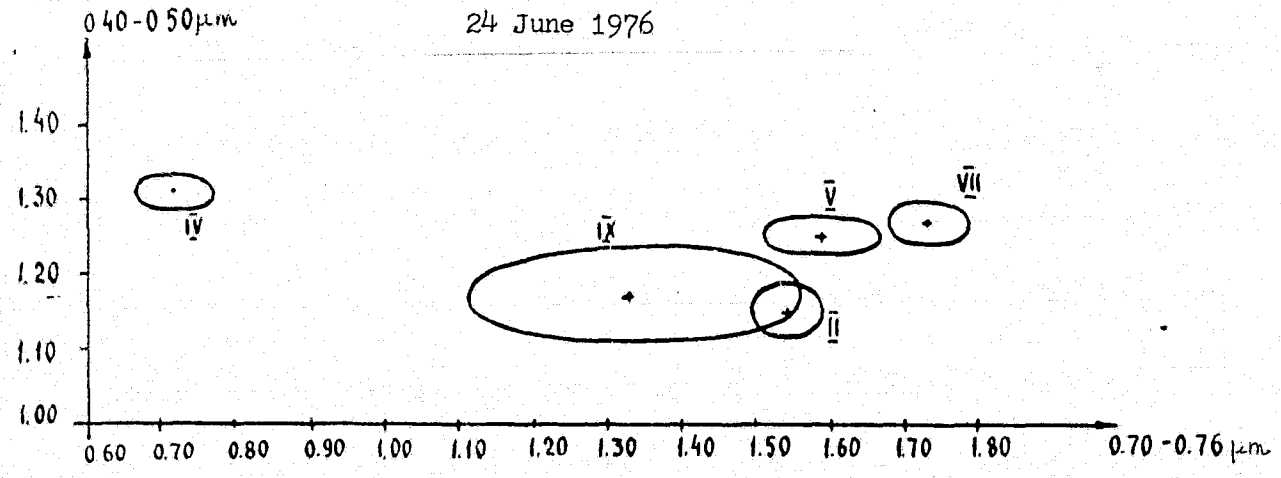


Fig. 3. Dependence of Quantity of Average Entropy (H) on Effective Wavelength (λ) of Spectrum Zone in Recognition by CSI



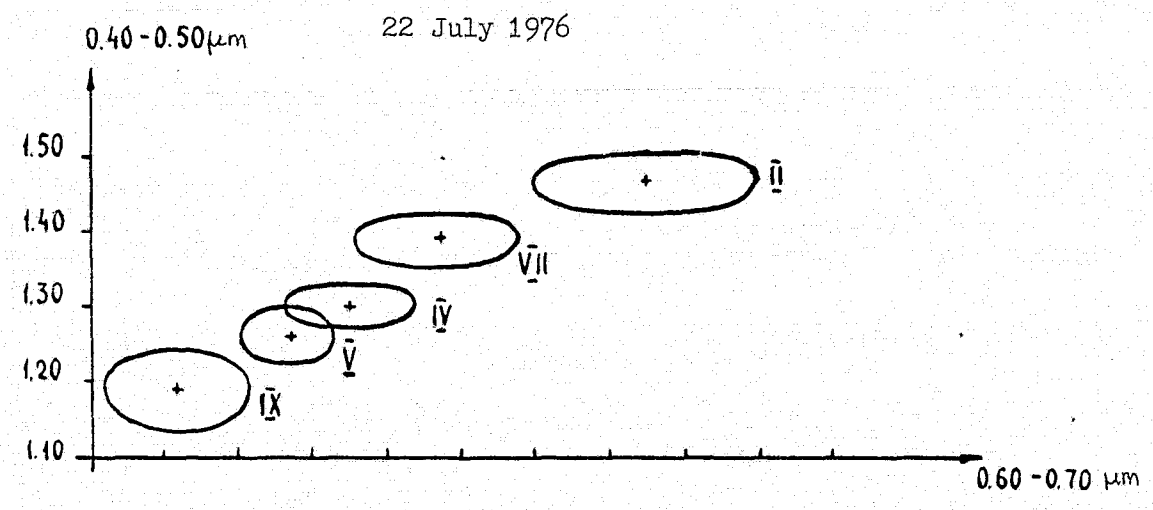
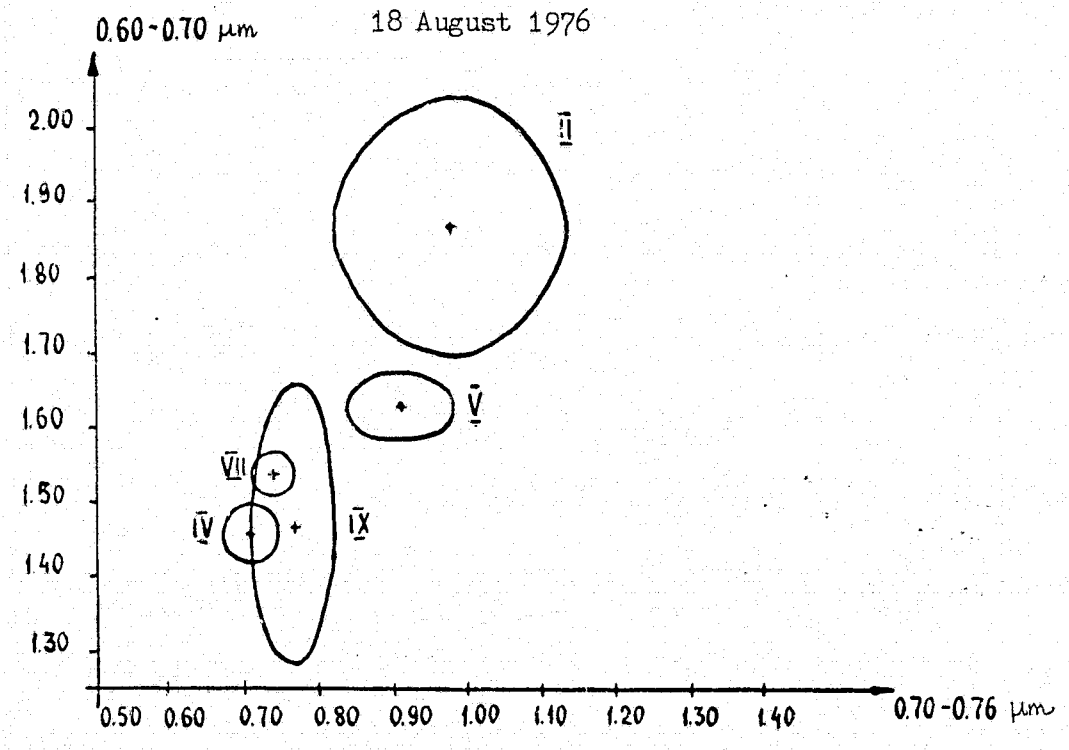


Figure 4 (continued on next page)



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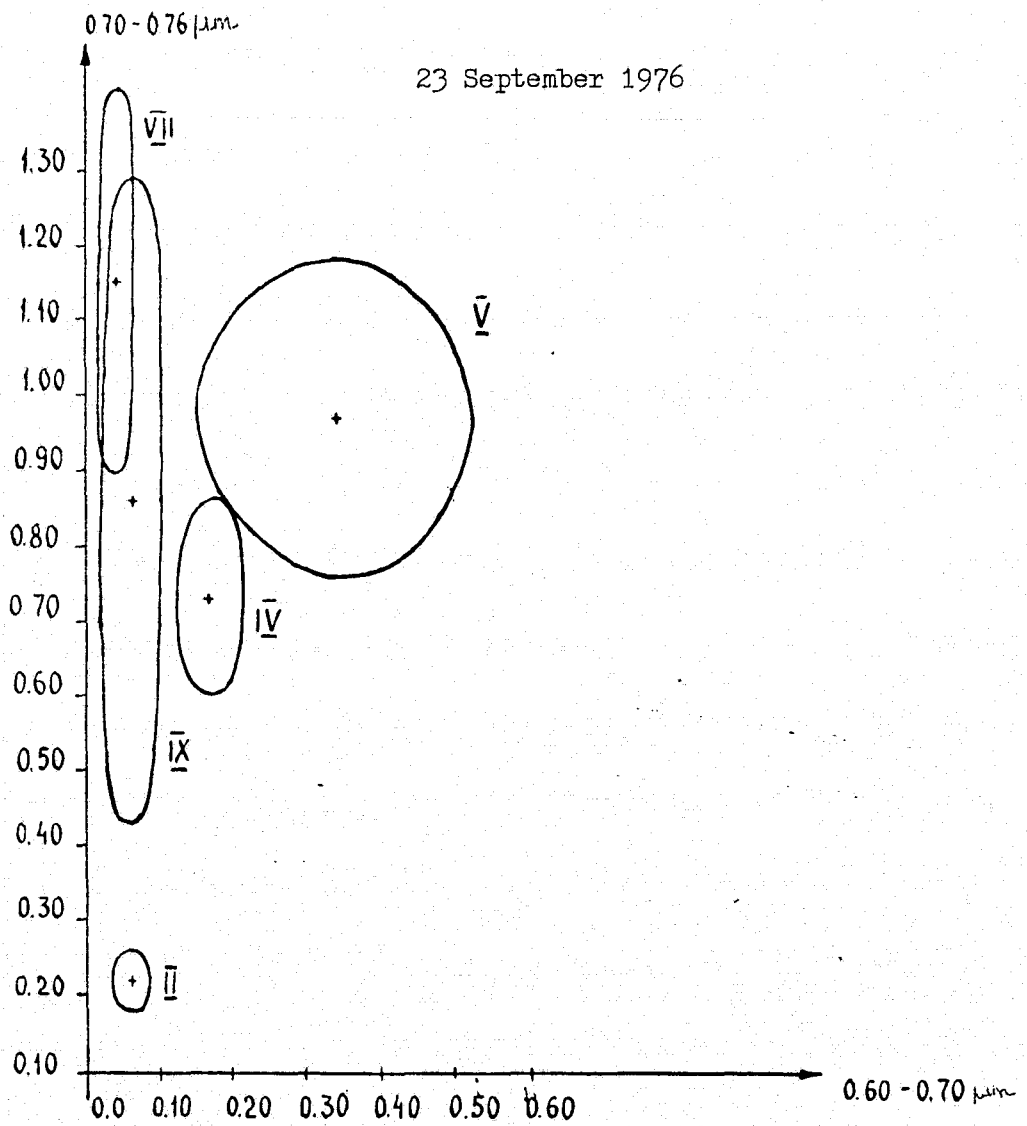

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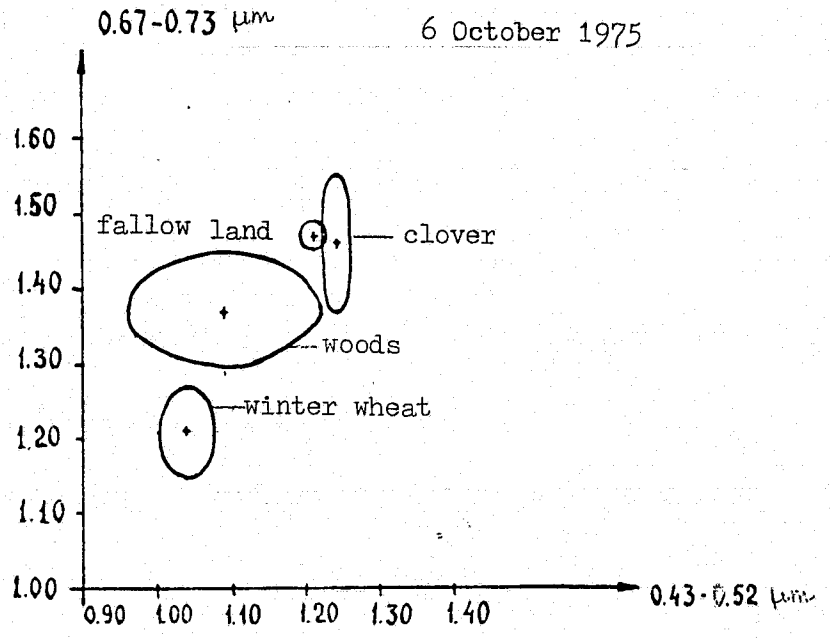

Figure 5 (continued from previous page)

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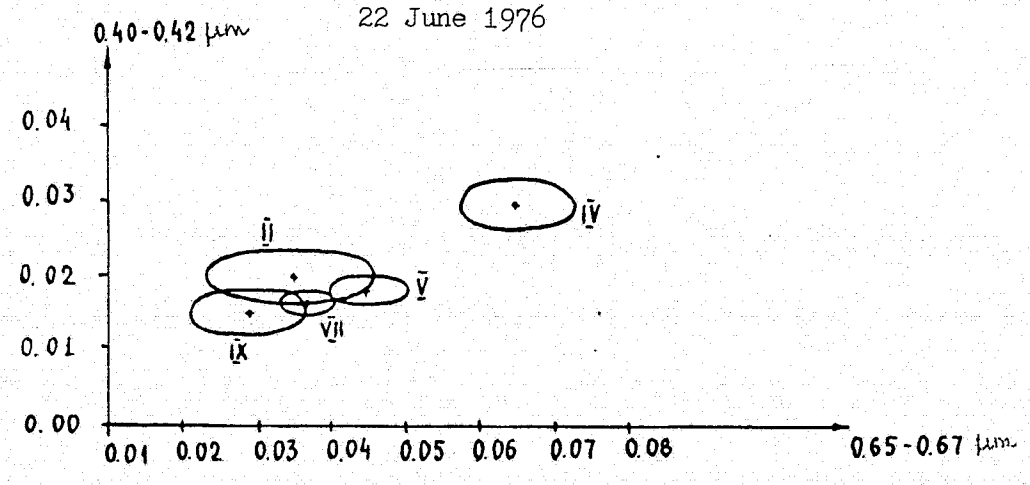
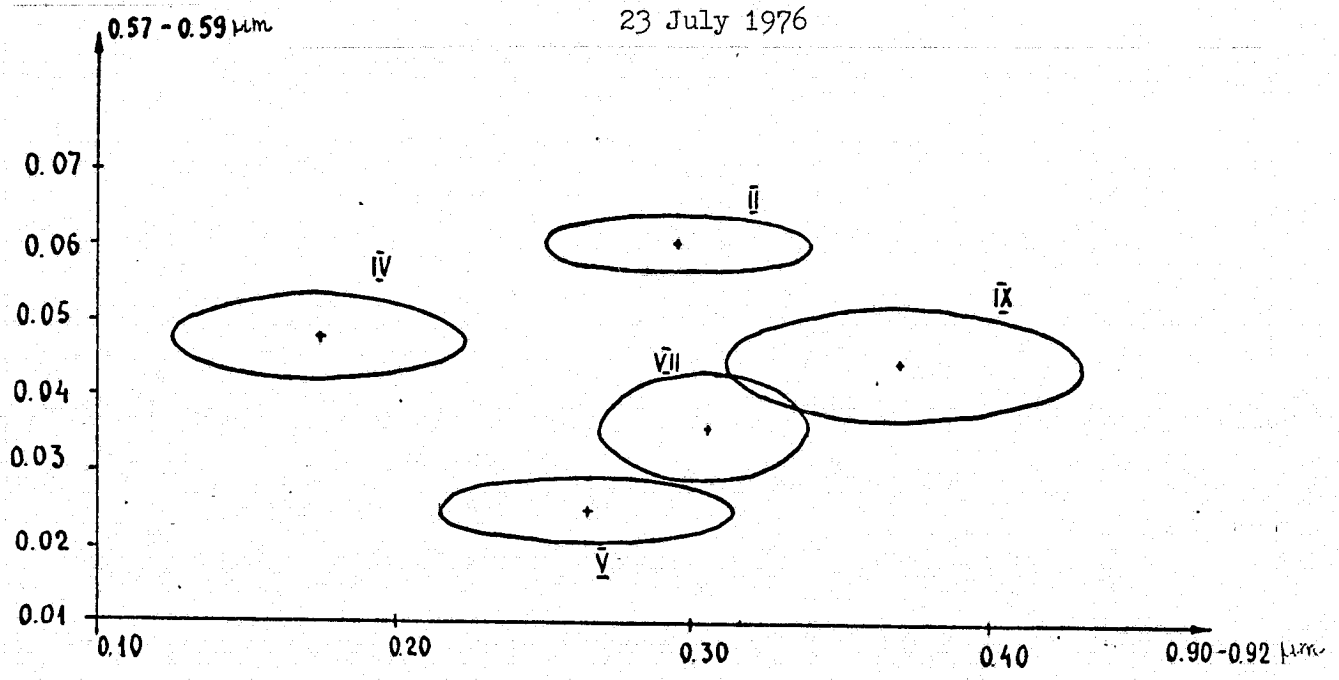


Figure 6 (continued on next page)



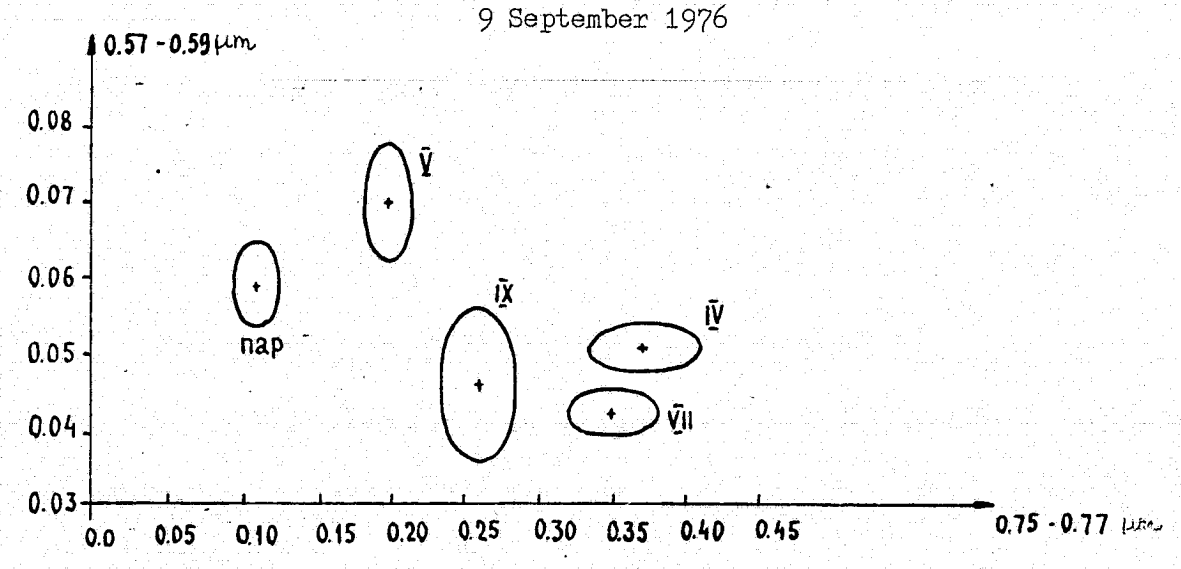


Figure 6 (continued from previous page)

RANKING OF SPECTRUM ZONES AND SEASONS ACCORDING TO INFORMATION CONTENT FOR RECOGNITION OF TEST TARGETS BY OPTIC DENSITIES OF IMAGES

Month	Winter wheat		Corn		Spring wheat		Clover		Oak	
	zones (μm)	Entropy	zones (μm)	Entropy	zones (μm)	Entropy	zones (μm)	Entropy	zones (μm)	Entropy
I	2	3	4	5	6	7	8	9	I0	II
June	0,40-0,50	0,2I	0,60-0,70	0	0,40-0,50	0,I0	0,70-0,76	0,02	0,70-0,76	0,05
	0,70-0,76	0,4I	0,70-0,76	0	0,70-0,76	0,4I	0,40-0,50	0,I3	0,50-0,60	0,I6
	0,60-0,70	0,63	0,40-0,50	0,05	0,60-0,70	0,54	0,60-0,70	0,I7	0,60-0,70	0,2I
	0,50-0,60	0,68	0,50-0,60	0,23	0,50-0,60	0,55	0,50-0,60	0,2I	0,40-0,50	0,24
July	0,50-0,60	0	0,40-0,50	0,I0	0,60-0,70	0,I3	0,50-0,60	0	0,50-0,60	0,02
	0,60-0,70	0,02	0,60-0,70	0,I6	0,40-0,50	0,I6	0,40-0,50	0,04	0,60-0,70	0,02
	0,40-0,50	0,04	0,70-0,76	0,I6	0,70-0,76	0,I7	0,60-0,70	0,08	0,40-0,50	0,07
	0,70-0,76	0,25	0,50-0,60	0,20	0,50-0,60	0,2I	0,70-0,76	0,27	0,70-0,76	0,2I
August	0,60-0,70	0,05	0,60-0,70	0,08	0,60-0,70	0,07	0,60-0,70	0,05	0,70-0,76	0,I5
	0,70-0,76	0,44	0,70-0,76	0,I3	0,40-0,50	0,34	0,70-0,76	0,I5	0,60-0,70	0,I6
	0,40-0,50	0,57	0,40-0,50	0,28	0,70-0,76	0,39	0,40-0,50	0,I7	0,40-0,50	0,23
September	0,70-0,76	0	0,60-0,70	0,08	0,40-0,50	0,0I	0,40-0,50	0,I4	0,70-0,76	0,22
	0,60-0,70	0,30	0,50-0,60	0,I2	0,60-0,70	0,09	0,70-0,76	0,I4	0,60-0,70	0,24
	0,40-0,50	0,40	0,70-0,76	0,I4	0,70-0,76	0,25	0,60-0,70	0,I4	0,50-0,60	0,25
	0,50-0,60	0,59	0,40-0,50	0,30	0,50-0,60	0,49	0,50-0,60	0,22	0,40-0,50	0,26
October	0,67-0,73	0,0I					0,43-0,52	0,06	0,67-0,73	0,08
	0,52-0,59	0,I3					0,52-0,59	0,I2	0,72-0,86	0,2I
	0,43-0,52	0,I7					0,67-0,73	0,I6	0,43-0,52	0,2I
	0,72-0,86	0,35					0,72-0,86	0,26	0,52-0,59	0,30

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Month	Plowing		Entire group of targets	
	zones (μm)	Entropy	zones (μm)	Entropy
	I2	I3	I4	I5
June			0,40-0,50	0,87
			0,70-0,76	0,46
			0,60-0,70	0,87
			0,50-0,60	I,05
July			0,40-0,50	0,20
			0,60-0,70	0,2I
			0,50-0,60	0,22
			0,70-0,76	0,55
August			0,60-0,70	0,2I
			0,70-0,76	0,66
			0,40-0,50	0,9I
September			0,70-0,76	0,42
			0,60-0,70	0,45
			0,40-0,50	0,62
			0,50-0,60	0,97
October	0,72-0,86	0,06	0,67-0,73	0,I8
	0,43-0,52	0,07	0,43-0,52	0,26
	0,52-0,59	0,09	0,52-0,59	0,33
	0,67-0,73	0,I0	0,72-0,86	0,47
		0,06	October	0.I8

[Translator's note: All commas in numerals represent decimal points]

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TABLE 5

RANKING OF SPECTRUM ZONES AND SEASONS ACCORDING TO INFORMATION CONTENT FOR RECOGNITION OF TARGETS UNDER STUDY BY COEFFICIENTS OF SPECTRUM INTENSITY

Month	Winter wheat		Corn		Spring wheat		Clover	
	zones (μm)	Entropy	zones (μm)	Entropy	zones (μm)	Entropy	zones (μm)	Entropy
I	2	3	4	5	6	7	8	9
June	0,86-0,88	0,45	0,65-0,67	0	0,55-0,57	0,27	0,40-0,42	0,I9
	0,90-0,92	0,48	0,72-0,74	0	0,65-0,67	0,28	0,49-0,5I	0,23
	0,40-0,42	0,52	0,86-0,88	0	0,90-0,92	0,30	0,86-0,88	0,23
	0,72-0,74	0,67	0,90-0,92	0	0,86-0,88	0,38	0,65-0,67	0,24
July	0,57-0,59	0	0,52-0,54	0,03	0,67-0,69	0	0,57-0,59	0,08
	0,52-0,54	0,06	0,86-0,88	0,03	0,57-0,59	0,02	0,43-0,45	0,I0
	0,62-0,64	0,I2	0,90-0,92	0,03	0,62-0,64	0,07	0,52-0,54	0,I3
	0,55-0,57	0,I3	0,97-0,99	0,I0	0,52-0,54	0,I3	0,67-0,69	0,I6
September			0,86-0,88	0,07	0,86-0,88	0,0I	0,57-0,59	0,08
			0,75-0,77	0,I2	0,75-0,77	0,0I	0,72-0,74	0,09
			0,90-0,9.	0,I5	0,90-0,92	0,02	0,86-0,88	0,II
			0,57-0,59	0,I8	0,55-0,57	0,04	0,67-0,69	0,II
Ranking of seasons	July	0	June	0	July	0	July	0.08
	June	0.45	July	0.03	Sept.	0.01	Sept.	0.08
			Sept.	0.07	June	0.27	June	0.19

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[Translator's note: All commas in numerals represent decimal points.]

(continued from previous page)

Month	Oak		Fallow land		Entire group of targets		Recommended set of zones
	zones (μm)	Entropy	zones (μm)	Entropy	zones (μm)	Entropy	
	I0	II	I2	I3	I4	I5	I6
June	0,67-0,69	0,09			0,40-0,42	0,76	0,40-0,42
	0,49-0,5I	0,II			0,65-0,67	0,76	0,65-0,67
	0,40-0,42	0,I7			0,90-0,92	0,76	0,86-0,88
	0,57-0,59	0,I9			0,86-0,88	0,78	0,90-0,92
July	0,72-0,74	0			0,57-0,59	0,22	0,57-0,59
	0,75-0,77	0,0I			0,62-0,64	0,38	0,90-0,92
	0,90-0,92	0,06			0,67-0,69	0,4I	0,52-0,54
	0,62-0,64	0,I2			0,52-0,54	0,42	0,62-0,64
September	0,75-0,77	0,0I	0,75-0,77	0	0,86-0,88	0,I2	0,57-0,59
	0,90-0,92	0,02	0,86-0,88	0	0,75-0,77	0,I3	0,75-0,77
	0,86-0,88	0,06	0,90-0,92	0	0,90-0,92	0,I7	0,86-0,88
	0,97-0,99	0,07	0,40-0,42	0,I	0,97-0,99	0,23	0,90-0,92

Ranking of seasons				
	July	0	Sept.	0.12
	Sept.	0.01	July	0.22
	June	0.09	June	0.76

[Translator's note: All commas in numerals represent decimal points.]

The quantity of entropy is not unequivocally related to the probability of recognition error. With the given amount of entropy one can only indicate the limits within which the value of probability of recognition error lies. Therefore, in order to judge the quantities of probability error calculations were made of the maximum and minimum probabilities of recognition error of each class of targets for the assigned values of entropy according to the formulas: /20

$$H = -[1 - p(\ell)_{min}] \log [1 - p(\ell)_{min}] - p(\ell)_{min} \log p(\ell)_{min} \quad (8)$$

$$H = -P(V_i)_{min} \log \frac{P(V_i)_{min}}{p(\ell)_{max} + P(V_i)_{min}} - \quad (9)$$

$$- p(\ell)_{max} \log \frac{p(\ell)_{max}}{p(\ell)_{max} + P(V_i)_{min}}$$

Here $P(V_i)_{min}$--the minimum a priori probability of class.

$P(1)_{min}$ and $P(1)_{max}$--respectively the minimum and maximum probability of recognition error of class V_i, if the recognition entropy equals H.

The results of the calculations are given in table 6.

TABLE 6 /21

Target $P(V_i)$ / H	Winter wheat 0.60	Corn 0.12	Spring wheat 0.16	Clover 0.06	Oak 0.06
0.05		<0.01		0.01	0.01
	<0.01	0.01	<0.01	0.02	0.02
0.10	<0.01	0.01	0.01	0.02	0.02
	0.01	0.02	0.02	0.05	0.05
0.20	0.03	0.03	0.03	0.03	0.03
	0.04	0.10	0.08	0.04	0.14
0.30	0.05	0.05	0.05	0.05	0.05
	0.08	0.18	0.15	0.24	0.24

5.2. Conclusions and recommendations

5.2.1. Calculation of the quantities of entropy and analysis of these data provide valuable information on the degree of comparative usefulness of different spectrum intervals for recognizing targets under study.

5.2.2. The information content of narrow spectrum intervals (CSI) on the average is higher than the information content of wide (multizonal aerial photograph).

Thus, in the recognition by coefficients of spectrum intensity already in two zones practically complete recognition is achievable in September and July /22 (fig. 6).

5.2.3. The best month for recognizing the studied targets is apparently July, the worst--June.

5.2.4. The information content of spectrum intervals for recognition during a season changes. Therefore the photography must occur in different spectrum zones depending on the season (tables 4, 5) in case of a limited set of intervals (for example, four) or with a constant expanded set of spectrum intervals. On the basis of table 5 one can preliminarily recommend the following set of eight intervals for the entire season: 0.40-0.42, 0.57-0.59, 0.62-0.64, 0.65-0.67, 0.75-0.77, 0.86-0.88 and 0.90-0.92 μm.

5.2.5. The graphs (fig. 1-3) reveal that even for the intervals located close in the spectrum, the information content changes rather sharply, so that the local minimums and maximums are separated from each other on the average by not more than 0.1 μm. Therefore, from the viewpoint of information content the narrow intervals are preferable. However, the question of the optimal width of intervals requires special studies. Probably for each selected spectrum zone its width will be the optimal.

5.2.6. The conclusions on the recommendations for specific intervals and the best time for recognition which were drawn from materials of one year should

be viewed as preliminary and subject to refinement during further studies.

6.0. Evaluation of the close correlation between the coefficients of spectrum intensity (CSI) and optic densities of zonal aerial photographs (D). /23

6.1. The degree of correlation of quantities CSI and D was determined by the data obtained on 22-24 June and 22-23 July. The hypothesis on the linear relationship between the quantities of optic density (D) and the logarithms of quantities for coefficients of spectrum intensity was verified. Due to the different width of spectrum zones of the spectrometer and aerial photography the average quantities of CSI from the narrow spectrum intervals included in the given wide zone were taken as equivalents to the spectrum zones of the photographs. The following quantities were obtained for the coefficients of correlation for various spectrum channels:

Date	0.4-0.5	0.5-0.6	0.6-0.7	0.7-0.8
22-24 June	0.25	-0.33	0.68	0.66
22-23 July	0.75	0.25	0.32	-0.25

Thus, the aforementioned data do not confirm the presence of a correlation between quantities CSI and D. However, one can also not conclude that it is lacking on the basis of these data. The lack of a correlation can be explained by a number of reasons, of which the most important are the following:

1) time asynchronism of data,

2) spatial asynchronism of data, lack of exact spatial tie of spectrometric measurements,

3) discrepancy in width of spectral intervals of spectrometer and aerial photography. /24

7.0. State of the question of evaluating the close correlation between optic densities of zonal aerial photographs and biomass of vegetation. /25

7.1. As a result of the analysis of the collected materials the presence of correlations between the biomass and any characteristics of zonal aerial

photographs was not successfully established. In order to confirm the presence or for strict proof of the lack of such a connection it is necessary to process a greater volume of initial data obtained under conditions of exclusion of interfering factors. Apparently, it is not sufficient to have the mean quantity of biomass for the entire field. It is necessary on certain fields to make repeated measurements of the biomass in the entire range of its changes with strict spatial fixation of measurement points.

8.0. Improvement in the composition and volume of observations of next year /26

8.1. As a result of the analysis of the collected materials certain deficiencies were defined in the technique of data collection.

8.2. It is necessary to have spatial fixation of spectrometric data. The most simple variant is fixation of the ends of the helicopter route and spectrometering along the route through various time intervals.

8.3. It is expedient to develop a detailed program of special biometric observations on certain fields which guarantees a sufficient volume of data fixed in the plan for computation of the correlation between biomass and the data of remote-controlled apparatus.

List of Appendices /27

Appendix 1 Materials of multizonal aerial photography.
Appendix 2 Materials of measurements of coefficients of spectrum intensity.
Appendix 3 Materials of ground observations.
Appendix 4 Ground photographs of fields.
Appendix 5 Sampling mean and standard deviations of optic densities of images.
Appendix 6 Tables of quantities of entropy.
Appendix 7 Technique for biological observations.
Appendix 8 Description of spectrometer.

Appendix 1 /28

Materials of Multizonal Aerial Photography

Log Book of Multizonal Photography /29

Section Kursk Mission 2 Date 24.06.76
Route number 1-2 Time (start) 9 h 07 min. (end) 9 h 20 min.

cameras	1	2	3	4	-	-
zone of spectrum	040-048	049-050	061-072	071-080		
type of camera	A-39	A-39	A-39	A-39		
foc. distance	100	100	100	100		
format	70 x 80	70 x80	70 x 80	70 x 80		
type of film	T-17	T-17	T-17	I-840		
filter	blue	green	red	infrared		
exposure	1:300	1:300	1:300	1:300		
stop aperture	3.5	5.0	6.3	3.5		
% overlap	50%	50%	50%	50%		
number of emulsion						

Log Book of Multizonal Photography /30

Section Kursk Mission 3 Date 22.07.76
Route number 1-2 Time (start) 8 h. 25 min. (end) 8 h. 45 min.

cameras	1	2	3	4
zone of spectrum	040-048	049-060	061-072	071-080
type of camera	A-39	A-39	A-39	A-39
foc. distance	100	100	100	100
format	70 x 80	70 x 80	70 x 80	70 x 80
type of film	T-17	T-17	T-17	I-840
filter	blue	green	red	infrared
exposure	1:300	1:300	1:300	1:300
stop aperture	4.2	6.3	7.8	4.2
% overlap	50%	50%	50%	50%
number of emulsion				

Log Book of Multizonal Photography /31

Section Kursk Mission 4 Date 18.08.76

Route number 1-2 Time (start) 10 h. 00 min. (end) 10 h. 20 min.

cameras	1	2	3	-	-	-
zone of spectrum	040-048	049-060	061-072			
type of camera	A-39	A-39	A-39			
foc. distance	100	100	100			
format	70 x 80	70 x 80	70 x 80			
type of film	T-17	T-17	T-17			
filter	blue	green	red			
exposure	1:300	1:300	1:300			
stop aperture	3.5	5.0	3.5			
% overlap	50%	50%	50%			
number of emulsion						

Log Book of Multizonal Photography /32

Section Kursk Mission 5 Date 23.09.76

Route number 1-2 Time (start) 9 h. 30 min.(end) 10 h. [illegible]

cameras	1	2	3	4
zone of spectrum	040-048	049-060	061-072	071-080
type of camera	A-39	A-39	A-39	A-39
foc. distance	100	100	100	100
format	70 x 80	70 x 80	70 x 80	70 x 80
type of film	T-17	T-17	T-17	I-840
filter	blue	green	red	infrared
exposure	1:300	1:300	1:300	1:300
stop aperture	3.5	4.0	5.2	5.0
% overlap	50%	50%	50%	50%
number of emulsion				

FLIGHT PARAMETERS

Section Kursk Mission 2 Date 24.06.76

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Route	Time hour, min. start end	Altitude meters	Course (degrees)	Drift angle (degree)	Ground speed (km/h)	True speed (km/h)	Visibility (km)	Cloud cover (%)
1	9h 07min -	5000	80	0	-	460	10	clear
2	- 9h 20min	5000	80	0	-	460	10	clear

FLIGHT PARAMETERS

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Section Kursk. Mission 3 Date 22.07.76

Route	Time hour, min. start end	Altitude (meters)	Course (degrees)	Drift angle (degree)	Ground speed km/h	True speed (km/h)	Visibility (km)	Cloud cover (%)
1	8 h - 25min.	5000	85	+ 6	-	420	8	clear
2	- 8 h 45min.	5000	85	+ 6	-	420	8	clear

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FLIGHT PARAMETERS

Section Kursk Mission 4 Date 18.08.76

Route	Time hour, min. start end	Altitude (meters)	Course (degree)	Drift angle (degree)	Ground speed (km/h)	True speed (km/h)	Visibility (km)	Cloud cover (%)
1	10 h - 00min.	5000	84	0	-	470	10	10-20%
2	- 10 h. 20min.	5000	84	0	-	470	10	10-20%

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FLIGHT PARAMETERS

Section Kursk Mission 5 Date 23.09.76

Route	Time hour, min. start end	Altitude (meters)	Course (degree)	Drift angle (degree)	Ground speed (km/h)	True speed (km/h)	Visibility (km)	Cloud cover (%)
1	9h - 30min.	5000	90	+ 6	-	400	8	clear
2	- 10 h 10min.	5000	90	+ 6	-	400	8	clear

Appendix 2. Materials of Measurements of Coefficients of Spectral Intensity /37

FIELD SPECTROMETRIC MEASUREMENTS /38

Mission _____ Date 22 June 1976 Time 12 h 43 min. No. Field I Crop winter wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)										stand. mean.	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,2	I,9	2,3	2,2	2,2	2,2	2,2	2,I	2,I	2,I	2.1	0.1
2	438	2,5	2,4	2,4	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2.5	0.1
3	500	3,9	3,5	3,I	3,3	3,I	3,I	3,5	3,0	3,I	3,I	3.3	0.3
4	530	5,8	5,4	5,4	5,6	5,8	5,4	5,8	5,2	5,0	5,0	5.4	0.3
5	560	6,8	6,8	6,8	7,I	7,4	7,II	7,4	6,6	6,8	6,6	6.9	0.3
6	582	8,3	6,0	6,6	6,8	6,9	6,9	6,9	6,6	6,9	6,6	6.9	0.6
7	622	5,5	5,2	5,2	5,2	5,5	5,I	4,2	4,5	4,8	4,2	4.9	0.5
8	657	4,4	4,4	4,3	4,8	4,8	4,3	4,9	4,3	4,3	4,8	4.5	0.3
9	682	6,I	7,0	5,2	6,I	5,6	5,6	6,I	5,2	5,8	5,6	5.8	0.5
10	728	25,0	28,3	29,3	26,4	26,4	26,4	25,0	25,0	26,4	25,7	26.4	1.4
11	755	4I,I	38,9	43,7	38,4	4I,I	42,I	43,2	40,0	42,I	39,5	41.0	1.8
12	866	45,3	43,2	43,2	38,9	4I,I	43,2	44,2	39,5	43,7	4I,6	42.4	2.1
13	910	33,7	39,7	43,3	38,3	40,0	4,4	48,6	39,2	42,8	40,8	41.0	4.0
14	983	40,2	35,4	40,8	37,3	38,5	42,7	43,I	40,0	42,3	38,5	40.5	3.2
15	1020	33,8	33,8	36,2	33,8	34,6	36,9	38,5	35,4	38,9	35,4	35.5	1.6

[Translator's note: All commas in this and subsequent tables of Appendix 2 represent decimal points]

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FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 12 h. 50 min. No. Field II Crop winter wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	I,9	2,I	2,3	I,9	2,I	I,7	I,9	I,9	I,8	I,7	2.0	0.2
2	438	2,3	2,2	2,4	2,3	2,5	2,2	I,9	2,0	2,2	2,0	2.2	0.2
3	500	3,I	3,I	3,I	3,0	3,0	2,8	2,6	2,2	3,0	2,6	2.9	0.3
4	530	4,8	4,8	5,2	5,4	5,0	4,6	4,4	4,6	4,8	4,4	4.8	0.3
5	560	6,6	6,6	6,8	7,I	6,6	6,0	6,0	5,5	6,6	5,5	6.3	0.5
6	582	6,3	6,3	6,0	7,I	6,3	6,3	6,0	5,4	6,6	5,4	6.2	0.5
7	622	5,2	4,8	4,8	5,5	4,5	4,5	4,5	4,5	5,2	3,9	4.7	0.5
8	637	4,3	4,3	5,0	2,6	3,5	3,5	3,5	3,9	3,5	3,0	3.5	0.6
9	682	6,I	5,2	5,6	5,6	5,2	4,8	4,8	4,8	4,8	4,8	5.2	0.5
10	728	26,4	2I,4	20,9	24,3	25,0	I9,3	I9,3	24,3	2I,4	I9,3	21.7	2.2
11	755	32,6	35,3	36,3	40,5	37,4	3I,I	28,4	33,7	30,0	30,5	33.6	3.8
12	866	43,7	36,8	36,3	32,5	36,8	30,5	28,9	36,3	33,7	36,3	35.9	4.2
13	910	33,I	36,7	35,3	39,7	37,8	32,5	29,4	33,9	33,I	35,3	34.7	2.9
14	983	33,5	34,6	34,6	38,I	38,5	3I,9	29,6	32,3	33,5	33,5	34.0	2.7
15	1020	3I,5	32,3	30,0	33,8	33,I	30,8	26,9	30,0	3I,5	29,2	30.9	2.0

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FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 14 h. 37 min. No. Field III Crop corn

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	10	mean	stand. deviat.
1	410	2,4	2,6	2,6	2,8	2,6	2,7	2,8	2,8	2,9	3.0	2.7	0.2
2	438	2,2	2,4	2,2	2,3	2,3	2,3	2,4	2,5	2,6	2.6	2.4	0.1
3	500	3,2	3,3	3,2	3,3	3,3	3,I	3,4	3,6	3,7	3.7	3.4	0.2
4	530	3,6	3,8	3,4	3,7	3,3	3,6	3,7	3,9	3,9	4.0	3.7	0.2
5	560	4,8	4,8	4,9	5,I	5,I	4,9	4,9	5,2	5,7	5.4	5.1	0.3
6	582	5,I	5,2	5,3	5,5	5,I	5,4	5,5	5,7	6,0	5.8	5.5	0.3
7	629	5,2	5,5	5,4	5,8	5,I	5,8	5,9	6,0	6,4	6.3	5.7	0.4
8	657	5,2	5,4	5,4	5,4	5,0	5,5	5,5	5,9	6,I	5.9	5.5	0.3
9	682	7,4	7,2	7,I	7,7	7,4	7,8	7,6	7,2	8,5	8.6	7.7	0.5
10	728	7,9	7,9	6,6	7,3	6,6	7,3	7,9	8,2	7,9	7.9	7.6	0.6
11	755	8,5	8,5	7,9	7,6	7,6	7,9	7,6	8,5	8,8	7.9	8.1	0.5
12	866	7,6	7,6	6,7	7,6	6,7	7,0	7,0	7,6	6,7	7.3	7.2	0.4
13	910	9,7	8,0	7,5	8,5	6,8	7,8	7,5	8,2	7,8	8.2	8.0	0.8
14	983	9,4	8,4	8,4	9,I	8,I	8,I	8,4	8,8	9,I	9.1	8.7	0.5
15	1020	9,5	9,3	9,3	I0,2	9,3	9,7	9,3	I0,2	I0,2	10.4	9.7	0.5

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 13 h. 45 min. No. Field IV Crop corn

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,7	2,7	2,8	2,7	2,8	2,8	2,9	2,9	3,0	3,2	2.9	0.2
2	438	2,6	2,6	2,5	2,5	2,4	2,6	2,6	2,6	2,9	2,9	2.6	0.2
3	500	3,7	3,9	3,9	3,6	3,8	3,9	4,0	4,0	4,4	4,2	3.9	0.2
4	530	3,9	4,I	3,9	3,9	3,7	3,9	4,0	4,0	4,4	4,I	4.0	0.2
5	560	5,5	5,7	5,7	5,4	5,6	5,7	5,8	5,8	6,3	6,3	5.8	0.3
6	582	6,5	6,I	6,I	6,I	6,0	6,5	6,5	6;4	6,9	7,2	6.4	0.4
7	622	6,6	6,8	6,2	6,5	6,3	6,8	6,8	7,0	7,3	7,3	6.8	0.4
8	657	6,5	6,3	6,3	6,2	6,2	6,3	6,3	6,0	7,4	7,0	6.5	0.4
9	682	9,I	8,8	8,9	8,3	8,2	8,0	9,I	8,9	9,7	9,9	8.9	0.6
10	728	8,4	8,6	8,I	7,8	8,I	8,I	8,4	8,I	8,9	8,9	8.3	0.4
11	755	8,5	9,0	8,5	8,0	8,0	8,5	8,0	8,3	9,4	9,7	8.6	0.6
12	866	8,9	8,4	7,6	8,I	7,3	8,4	8,I	8,4	8,4	9,2	8.3	0.6
13	910	8,7	8,8	7,7	7,7	7,9	8,9	7,9	8,3	8,9	9,I	8.4	0.6
14	983	I0,0	9,7	8,9	8,9	9,2	9,7	9,2	9,2	I0,3	I0,8	9.6	0.6
15	1020	II,2	II,2	I0,8	9,8	I0,3	II,2	II,2	I0,6	II,8	I2,3	11.0	0.7

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FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 13 h. 40 min. No. Field V Crop spring wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	I,7	I,8	I,9	I,9	I,8	I,8	I,9	I,9	I,9	I,9	1.8	0.1
2	438	2,0	2,I	2,9	2,I	2,3	2,2	2,3	2,3	2,2	2,2	2.3	0.2
3	500	2,5	2,8	3,0	3,0	3,I	3,0	3,I	3,2	3,2	3,0	3.0	0.2
4	530	4,7	4,8	5,I	5,0	5,2	5,0	5,0	5,4	5,4	5,2	5.1	0.2
5	560	6,6	6,9	7,3	7,0	7,3	7,2	7,4	7,4	7,4	7,4	7.2	0.3
6	582	6,3	6,5	6,9	6,6	6,9	7,0	7,0	7,2	7,2	7,I	6.9	0.3
7	622	4,4	4,8	4,9	4,5	5,2	5,3	5,2	5,3	5,3	5,3	5.0	0.3
8	657	4,0	3,9	4,5	4,5	4,6	4,5	4,6	4,7	4,7	4,6	4.5	0.3
9	682	4,8	5,0	5,5	5,3	5,4	5,5	5,5	5,5	5,6	5,5	5.4	0.3
10	728	2I,0	22,4	22,8	22,2	23,4	22,8	23,4	23,4	23,5	23,4	22.8	0.8
11	755	30,5	30,3	32,6	30,5	32,4	32,I	32,9	3I,8	32,6	33,7	31.9	1.2
12	866	28,9	29,5	32,I	30,5	32,I	30,8	3I,3	3I,I	3I,I	32,4	31.0	1.1
13	910	27,6	28,6	30,0	30,4	30,4	30,0	30,4	28,8	29,7	30,7	29.7	1.0
14	983	27,3	28,8	3I,2	29,4	30,6	29,2	3I,2	30,6	30,0	3I,3	30.0	1.3
15	1020	28,3	3I,0	3I,3	3I,3	32,I	3I,2	3I,7	32,I	3I,7	32,3	31.4	1.2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 14 h. 46 min. No. Field VI' Crop spring wheat

No. channel	λ-effect (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,8	I,9	I,8	I,9	I,7	I,6	I,6	I,6	I,7	I,9	1.7	0.1
2	438	2,4	2,3	2,3	2,2	2,I	2;0	2,2	2,I	2,2	2,2	2.2	0.1
3	500	3,0	3,I	3,0	3,I	2,8	2,6	2,6	2,6	2,9	3,0	2.9	0.2
4	530	4,9	5,I	5,3	4,9	4,5	4,2	4,4	4,4	4,7	4,8	4.7	0.3
5	560	6,5	6,3	6,9	6,5	5,8	5,6	5,7	5,9	6,3	6,4	6.2	0.4
6	582	6,I	6,4	6,5	6,4	4,9	5,7	5,5	5,8	6,2	6,I	6.0	0.5
7	622	4,4	4,6	4,7	4,7	4,2	4,0	4,0	4,3	4,7	4,6	4.4	0.3
8	657	3,0	3,3	3,5	3,0	2,7	2,6	2,7	2,9	3,2	3,2	3.0	0.3
9	682	4,9	5,4	5,3	5,3	4,7	4,7	4,5	4,7	4,9	4,7	4.9	0.3
10	728	20,8	22,3	22,3	I9,5	I8,9	I8,6	I7,I	I8,9	I9,9	I9,2	19.8	1.6
11	755	33,2	32,6	32,I	28,9	26,I	27,4	27,4	26,6	27,I	28,4	29.0	2.7
12	866	33,2	33,2	3I,I	28,7	25,3	27,9	26,8	27,9	25,8	27,4	28.7	2.8
13	910	3I,7	3I,7	30,4	26,7	24,7	26,I	25,6	26,7	25,8	25,8	27.5	2.7
14	983	30,6	3I,0	3I,9	27,I	25,2	26,7	25,2	25,8	25,8	27,7	27.7	2.5
15	1020	29,7	30,8	29,7	24,7	25,5	25,2	25,2	26,3	26,3	26,3	27.0	2.2

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 13 h. 25 min. No. Field VII Crop clover

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,6	I,6	I,5	I,6	I,7	I,5	I,6	I,6	I,7	I,7	1.6	0.1
2	438	2,I	2,0	2,0	2,I	2,0	2,0	2,I	2,I	2,I	2,I	2.1	0.1
3	500	2,8	2,7	2,5	2,8	2,7	2,6	2,8	2,6	2,4	2,6	2.7	0.1
4	530	4,8	4,7	4,4	4,4	4,6	4,7	5,0	5,0	4,9	4,8	4.7	0.2
5	560	6,I	6,2	6,3	6,I	6,2	6,2	6,5	5,8	6,4	6,4	6.2	0.2
6	582	5,7	6,0	5,7	5,7	5,8	5,7	6,2	6,0	6,I	6,I	5.9	0.2
7	622	4,7	4,5	4,3	4,5	4,5	4,9	4,5	4,6	4,9	4,8	4.6	0.2
8	657	3,5	3,7	3,5	3,5	3,7	3,5	4,0	3,8	3,7	3,8	3.7	0.2
9	682	4,7	5,4	4,6	4,6	4,9	4,9	4,9	5,2	5,2	5,I	5.0	0.3
10	728	24,7	23,5	22,5	23,5	24,0	24,0	24,0	24,9	25,6	25,2	24.2	0.9
11	755	33,2	3I,8	32,6	30,3	3I,6	32,6	32,4	3I,9	33,7	34,7	32.5	1.2
12	866	30,8	29,7	30,3	29,5	30,0	30,8	30,3	3I.I	30,5	33,2	30.6	1.0
13	910	30,4	30,0	30,3	28,2	29,9	30,7	30,7	22,2	30,7	33,I	29.6	2.9
14	983	30,8	3I,2	3I,3	29,4	30,8	30,8	30,8	3I,5	33,7	33,3	31.4	1.3
15	1020	29,2	29,2	29,2	28,4	28,8	29,2	28,8	30,4	3I,5	30,4	29.5	1.0

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 14 h. 50 min. No. Field VIII' Crop clover

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,8	I,7	I,6	I,7	I,8	I,8	I,8	I,7	I,6	I,8	1.7	0.1
2	438	2,I	2,2	2,I	2,2	2,I	2,I	2,I	2,I	2,I	2,3	2.2	0.1
3	500	2,7	2,7	2,7	2,7	2,7	2,7	2,6	2,5	2,6	2,8	2.7	0.1
4	530	4,4	4,9	4,9	4,8	4,7	4,4	4,7	4,6	4,6	5,I	4.7	0.2
5	560	6,0	6,4	6,5	6,5	6,0	6,0	6,0	6,I	6,I	6,6	6.2	0.2
6	582	5,6	6,0	6,4	6,0	5,9	5,9	6,0	6,0	5,8	6,4	6.0	0.2
7	622	4,4	4,7	4,8	4,7	4,7	4,6	4,6	4,5	4,6	5,I	4.7	0.2
8	657	3,5	3,3	4,4	4,4	3,7	3,7	4,I	3,7	3,5	3,5	3.8	0.4
9	682	5,0	5,2	4,8	5,0	5,0	5,I	5,0	5,0	5,I	5,2	5.0	0.1
10	728	2I,8	23,2	24,6	23,6	22,5	22,I	24,3	25,0	22,9	27,I	23.7	1.6
11	755	29,7	3I,6	32,4	32,I	28,4	27,4	3I,I	32,6	30,8	33,9	31.0	2.0
12	866	27,I	3I,3	32,I	29,5	26,I	26,6	30,0	3I,3	28,4	36,6	30.0	3.1
13	910	25,7	3I,I	3I,I	29,2	26,7	25,7	28,6	3I,9	27,4	34,0	29.1	2.8
14	983	I9,2	32,9	3I,9	3I,0	29,2	27,I	29,6	32,7	28,8	34,6	29.7	4.3
15	1020	26,5	30,8	30,8	30,0	26,9	26,2	27,3	30,8	29,7	3I,9	28.9	2.2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 13 h. 55 min. No. Field IX Crop oak woods

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	I,7	I,8	I,5	I,3	I,4	I,5	I,6	I,6	I,5	I,4	1.5	0.2
2	438	2,0	2,I	I,9	I,6	I,6	I,8	I,9	2,0	I,9	I,9	1.9	0.2
3	500	2;3	2,5	2,0	2,0	I,8	2,2	2,I	2,3	2,3	2,2	2.2	0.2
4	530	4.5	4,7	3,9	3,7	3,6	3,9	4,I	4,4	4,4	4,4	4.2	0.4
5	560	6,5	6,4	5,4	5,3	5,0	5,5	5,5	6,2	6,2	6,2	5.8	0.5
6	582	5,8	5,9	5,0	4,8	4,5	5,I	5,0	5,8	5,8	5,6	5.3	0.5
7	629	4,4	4,5	3,7	3,5	3,2	3,6	3,7	3,7	4,4	3,9	3.9	0.4
8	657	3,I	3,2	2,8	2,6	2,2	2,6	3,I	2,8	3,5	3,2	2.9	0.4
9	682	4,2	4,2	3,8	3,4	3,2	3,8	3,9	4,4	4,2	4,2	3.9	0.4
10	728	24,3	25,4	20,0	I9,6	20,5	2I,8	22,I	23,6	24,6	23,9	22.6	2.1
11	755	35,3	36,I	3I,6	28,9	25,3	32,6	34,2	35,8	35,5	35,0	33.0	3.5
12	866	32,I	33,2	29,5	26,I	23,4	30,8	3I,8	33,9	32,I	3I,3	30.4	3.3
13	910	34,9	35,3	3I,0	28,3	25,4	32,4	32,2	35,0	35,3	33,3	32.3	3.3
14	983	34,0	34,6	3I,3	27,9	26,0	32,9	33,7	35,8	33,7	34,2	32.4	3.1
15	1020	33,3	33,9	29,6	26,9	24,2	3I,2	30,8	33,8	3I,9	3I,5	30.7	3.1

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 14 h. 56 min. No. Field XII Crop unmowable steppe

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	I,8	I,5	I,8	I,8	I,8	I,8	I,9	I,8	I,8	I,8	1.8	0.1
2	438	2,0	2,0	2,I	2,2	2,2	2,3	2,3	2,3	2,3	2,3	2.2	0.1
3	500	3,0	2,8	3,I	3,4	3,3	3,2	3,2	3,2	3,2	3,5	3.2	0.2
4	530	4,8	4,8	5,2	5,4	5,3	5,4	5,4	5,4	5,5	5,9	5.3	0.3
5	560	6,7	6,6	7,I	8,2	7,0	7,4	7,2	7,2	7,4	7,8	7.3	0.5
6	582	6,6	6,5	6,9	7,4	7,3	7,2	6,8	7,I	7,3	7,6	7.1	0.4
7	629	5,8	5,6	5,9	6,0	6,0	5,8	5,6	5,8	6,2	6,4	5.9	0.2
8	657	4,5	4,5	4,9	4,9	4,7	4,9	5,I	5,I	4,7	5,I	4.8	0.2
9	682	5,6	5,8	6,I	6,4	6,I	6,2	6,0	6,I	6,I	6,2	6.2	0.2
10	728	2I,3	2I,7	22,6	2I,4	22,3	24,7	23,8	24,I	23,2	23,8	22.9	1.2
11	755	25,9	25,4	26,6	25,0	25,9	27,6	29,2	27,9	28,7	29,2	27.1	1.6
12	866	26,3	26,3	26,6	25,4	27,9	29,7	29,2	28,7	27,6	27,I	27.5	1.4
13	910	25,3	25,0	25,7	25,3	26,I	29,3	28,6	27,5	26,7	26,7	26.6	1.5
14	938	26,5	26,5	26,2	26,5	30,0	30,0	28,7	29,2	28,5	28,5	28.0	1.5
15	1020	26,9	27,2	28,8	28,8	28,5	3I,7	30,4	30,I	29,6	29,6	29.2	1.4

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 15 h. 10 min. No. Field XIII Crop unmowable steppe

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,4	I,6	I,6	I,7	I,6	I:5	I,6	I,5	I,6	I,7	1.6	0.1
2	438	I,8	I,8	2,I	2,I	2,0	2,I	2,0	2,0	2,I	2,0	2.0	0.1
3	500	2,5	2,6	3,0	2,8	3,I	2,7	2,7	3,0	3,0	3,I	2.8	0.2
4	530	4,4	4,6	5,I	5,2	5,I	4,9	4,8	4,9	5,3	5,5	5.0	0.3
5	560	6,3	6,6	7,0	7,0	6,7	6,7	7,0	6,8	7,5	7,2	6.9	0.3
6	582	5,8	6,I	6,4	6,8	6,4	6,4	6,6	6,4	6,9	7,I	6.4	0.4
7	629	4,8	5,0	5,6	5,6	5,3	5,3	5,5	5,5	5,8	5,8	5.4	0.3
8	657	4,3	4,5	4,9	5,I	4,7	4,7	4,5	4,5	5,3	4,7	4.7	0.3
9	682	5,3	5,I	5,8	6,0	5,6	5,6	5,7	5,6	5,8	5,8	5.6	0.3
10	728	22,0	2I,7	23,5	23,5	2I,7	22,4	23,I	22,4	23,5	23,5	22.7	0.8
11	755	27,I	27,3	28,9	29,7	28,4	27,6	27,6	27,I	29,5	28,9	28.2	1.0
12	866	26,7	27,6	28,9	30,0	28,6	28,3	28,9	28,4	28,7	28,9	28.5	0.9
13	910	24,9	25,6	28,0	27,5	26,6	26,3	26,6	26,3	27,3	27,8	26.7	1.0
14	938	25,9	27,0	28,8	29,6	28,I	28,I	28,5	28,5	30,0	29,6	28.4	1.2
15	1020	26,8	27,8	29,I	30,7	28,8	29,4	29,4	29,I	30,4	3I,0	29.9	1.3

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 15 h. 05 min. No. Field X Crop steppe pasturable

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,9	I,9	I,9	I,9	I,8	I,9	I,9	I,9	I,9	I,9	1.9	0.0
2	438	2,2	2,I	2,I	2,I	2,I	2,I	2,I	2,I	2,2	2,3	2.1	0.1
3	500	3,3	3,2	3,3	3,2	3,3	3,0	2,9	3,0	3,0	3,7	3.2	0.2
4	530	5,3	5,3	5,4	5,4	5,5	5,3	5,3	5,I	5,4	5,9	5.4	0.2
5	560	6,8	6,7	7,I	7,I	7,I	7,0	6,7	7,I	7,I	7,6	7.0	0.3
6	582	6,6	6,4	7,0	6,6	6,8	6,5	6,6	7,0	7,0	7,5	6.8	0.3
7	629	5,9	5,4	5,9	5,7	6,0	5,3	5,6	5,6	6,0	6,2	5.8	0,3
8	657	4,9	4,7	5,3	5,3	5,I	4,9	5,I	5,3	5,5	5,5	5.2	0.3
9	682	5,8	6,0	6,3	6,3	6,0	6,0	5,8	6,2	6,2	6,7	6.1	0.3
10	728	22,9	22,9	23,2	22,5	23,9	2I,I	23,2	22,5	23,2	22,2	22.8	0.8
11	755	28,I	26,3	26,3	27,8	27,6	29,9	27,3	27,I	26,3	26,3	27.3	1.1
12	866	26,6	27,6	26,6	27,6	27,3	29,9	27,3	27,3	27,0	26,3	27.4	1.0
13	910	24,9	25,6	25,4	25,I	26,3	27,5	26,3	26,3	26,3	25,4	25.9	0.8
14	983	27,I	27,I	26,3	26,7	27,8	28,8	27,8	28,5	27,8	27,I	27.5	0.8
15	1020	26,8	27,I	25,9	27,7	28,0	28,6	27,8	28,9	27,7	28,6	27.7	0.9

REPRODUCIBILITY OF THE ORIGINAL PAGE

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 22 June 1976 Time 15 h. 01 min. No. Field XIV Crop steppe mowable

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,7	I,6	I,6	I,7	I,6	I,7	I,7	I,8	I,7	I,9	1.7	0.1
2	438	2,I	2,0	2,0	2,0	2,2	2,I	2,2	2,2	2,3	2,3	2.1	0.1
3	500	3,0	2,8	3,0	3,2	3,I	2,8	3,0	3,2	3,0	3,2	3.0	0,2
4	530	5,0	4,9	5,I	5,I	5,I	5,3	5,5	5,7	5,4	5,3	5.2	0.2
5	560	6,8	7,0	6,9	7,3	7,3	7,0	7,5	7,3	7,3	7,5	7.2	0.2
6	582	6,4	6,6	6,9	6,9	6,9	6,8	7,2	7,2	7,0	7,4	7.0	0.2
7	629	5,7	5,9	5,6	6,0	5,7	5,7	6,I	6,3	5,7	6,3	5.9	0.3
8	657	4,9	4,8	5,I	5,I	5,5	4,9	4,9	4,9	5,I	5,I	5.0	0.2
9	682	5,6	6,0	6,0	6,2	6,0	6,0	6,2	6,5	6,I	6,7	6.1	0.3
10	728	2I,4	22,0	2I,4	2I,7	23,7	23,7	23,7	23,7	23,4	25,4	23.2	1.3
11	755	26,9	27,2	25,9	26,9	29,I	29,I	28,9	29,I	3I,5	32,3	28.9	2.1
12	866	28,2	26,6	25,2	26,6	29,5	29,0	28,5	29,8	30,6	3I,7	28.6	2.0
13	910	26,6	24,9	24,I	25,8	28,2	28,4	27,6	27,8	28,8	30,2	27.3	2.0
14	983	27,5	26,3	25,4	26,0	28,4	29,0	28,4	28,4	30,2	30,5	28.1	1.8
15	1020	29,7	29,2	28,4	29,4	3I,0	3I,0	3I,0	3I,0	3I,0	32,6	30.4	1.2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 12 h. 25 min. No. Field II Crop winter wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,2	2,3	2,3	2,2	2,4	2,4	2,6	2,3	2,4	2,4	2.4	0.1
2	438	2,8	2,8	2,8	3,0	3,0	3,0	3,2	3,I	3,3	3,0	3.0	0.3
3	500	4,6	4,5	5,I	5,5	5,5	5,7	5,4	5,7	5,4	5,I	5.3	0.4
4	530	6,0	6,0	6,0	6,3	6,0	6,7	6,3	6,7	6,7	6,4	6.3	0.3
5	560	7,0	6,6	6,6	6,7	6,9	7,6	7,4	7,5	7,6	7,4	7.1	0.4
6	582	5,6	5,8	6,0	5,8	6,0	6,3	6,3	6,3	6,3	6,2	6.1	0.2
7	629	5,I	5,0	5,2	5,I	5,2	5,2	5,4	5,8	5,4	5,2	5.3	0.2
8	657	4,6	4,3	4,3	5,0	4,6	5,0	5,2	4,6	4,2	4,2	4.6	0.3
9	682	4,9	4,9	5,2	4,7	4,9	5,2	5,4	5,I	5,4	5,I	5.1	0.2
10	728	I8,7	I9,0	I9,2	I8,7	I9,2	2I,8	I8,7	I8,7	23,4	20,0	19.7	1.5
11	755	24,I	24,0	20,4	I9,8	2I,0	24,I	I9,4	22,4	23,5	22,4	22.1	1.7
12	866	27,4	26,0	26,2	26,4	26,4	29,0	26,9	25,I	30,3	27,7	27.1	1.5
13	910	28,I	28,0	28,I	28,5	29,5	32,0	29,5	29,3	33,5	28,5	29.5	1.8
14	983	28,3	28,0	26,6	26,6	25,4	29,4	28,3	26,6	3I,8	27,4	27.8	1.8
15	1020	30,9	29,0	30,6	29,2	30,9	33,6	32,5	3I,3	34,8	30,6	31.3	1.8

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 12 h. 15 min. No. Field IV Crop corn

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	2,7	2,8	2,5	2,7	2;3	2,4	3,0	3,I	3,2	2,4	2.7	0.3
2	438	3,0	3,0	2,9	2,9	2,6	2,9	3,I	3,2	3,6	2,6	3.0	0.3
3	500	3,7	3,8	3,6	3,8	3,2	3,8	4,0	4,0	4,4	3,3	3.8	0.3
4	530	4,2	4,I	4,I	4,3	4,I	4,8	4,4	4,5	4,7	4,3	4.4	0.3
5	560	4,7	4,5	5,I	4,9	4,2	4,9	5,I	4,8	5,3	4,5	4.8	0.3
6	582	4,8	4,9	4,8	4,8	4,3	4,9	4,9	5,2	5,3	4,3	4.8	0.3
7	629	4,2	4,I	4,3	4,I	3,2	3,8	4,2	4,4	4,6	3,9	4.1	0.4
8	657	3,8	4,3	4,8	4,3	3,6	4,0	4,3	4,3	5,3	3,4	4.2	0.6
9	682	4,6	4,6	4,6	4,6	3,6	3,9	4,7	4,5	4,0	3,7	4.3	0.4
10	728	I2,I	I2,I	I2,I	I3,I	I5,2	I6,2	I5,2	I2,I	I0,6	I4,2	13.3	1.8
11	755	I3,6	I3,6	I4,4	I4,4	I6,6	2I,7	I6,I	I3,6	I3,2	20,3	15.8	3.0
12	866	I4,8	I4,8	I6,9	I6,5	I5,0	22,I	I6,9	I5,4	I5,6	20,4	16.8	2.5
13	910	I4,5	I4,6	I7,4	I7,0	I7,2	22,5	I8,7	I6,2	I5,7	I9,9	17.4	2.5
14	983	I7,5	I7,5	20,0	I9,5	2I,2	26,0	20,8	20,6	I8,8	22,9	20.5	2.6
15	1020	I9,I	20,0	20,2	2I,7	20,3	25,4	2I,7	20,3	2I,5	2I,5	21.2	1.7

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 12 h. 20 min. No. Field V Crop spring wheat

No. channel	λ-effect (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,96	I,7	2;I	I,8	I,7	I,8	2,I	2,3	2,I	2,I	2.0	0.2
2	438	I,9	2,I	2,I	2,I	I,9	2,I	2,4	2,4	2,7	2,4	2.2	0.3
3	500	2,6	3,5	2,8	2,8	2,5	2,9	3,2	2,7	2,9	3,2	2.9	0.3
4	530	3,5	3,5	3,6	3,3	3,I	3,5	3,9	3,6	4,0	4,0	3.6	0.3
5	560	3,5	3,8	3,9	3,7	3,5	4,0	4,5	4,2	4,4	4,4	4.0	0.4
6	582	2,3	2,4	2,4	2,4	2,3	2,4	2,8	2,6	2,8	2,8	2.5	0.2
7	629	2,7	2,6	2,9	2,7	2,9	2,7	2,9	2,9	3,I	3,I	2.9	0.2
8	657	I,8	2,I	I,6	2,I.	I,5	2,0	I,8	I,8	I,8	2,I	1.9	0.2
9	682	2,4	2,3	2,5	2,7	2,5	2,4	2,7	2,7	3,0	2,8	2.6	0.2
10	728	I3,3	I4,8	I4,8	I5,4	I3,7	I4,8	I8,7	I5,4	I8,I	I6,5	15.6	1.7
11	755	I9,2	24,I	24,I	20,5	I9,2	23,2	23,6	2I,0	23,6	2I,0	22.0	2.0
12	866	23,8	28,I	28,I	22,3	22,3	26,0	28,3	23,8	28,I	25,8	25.7	2.5
13	910	23,5	29,I	30,4	25,8	22,8	26,0	27,7	25,5	28,4	26,2	26.5	2.4
14	983	26,6	30,5	3I,4	26,6	23,7	26,8	30,8	26,4	3I,0	28,7	28.3	2.6
15	1020	22,9	25,7	27,I	23,6	20,7	23,8	25,2	22,7	26,9	24,3	24.3	2.0

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 10 h. 10 min. No. Field VII Crop clover

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	3,5	2,9	2,9	3,5	3,5	3,5	3,5	3,2	3,I	2,4	3.2	0.4
2	438	4,0	3,5	3,8	4,4	4,2	4,2	4,I	3,7	3,4	3,I	3.8	0.4
3	500	4,8	3,9	4,4	5,3	4,5	4,9	5,I	4,8	4,5	3,6	4.6	0.5
4	530	5,3	5,0	4,8	5,3	5,3	5,2	5,8	5,5	5,0	4,4	5.2	0.4
5	560	5,8	5,0	5,5	8,7	5,6	5,8	5,9	5,7	4,8	4,5	5.8	1.1
6	582	3,7	3,2	3,9	3,9	3,9	3,7	3,8	3,7	3,I	2,8	3.6	0.4
7	629	4,4	3,9	3,9	4,7	4,7	4,3	4,6	4,7	4,2	3,3	4.3	0.5
8	657	4,2	3,4	3,4	4,2	4,2	4,2	4,4	3,6	3,6	3,9	3.9	0.4
9	682	5,9	5,2	5,4	6,3	6,2	6,2	6,2	5,9	5,2	4,3	5.7	0.6
10	728	2I,2	I8,I	20,4	2I,2	I9,8	I9,2	I8,I	I9,8	2I,2	I8,7	19.8	1.2
11	755	26,9	24,4	27,6	24,9	25,9	23,4	25,9	24,9	27,6	23,4	25.5	1.6
12	866	27,I	27,I	28,6	28,I	28,I	27,I	28,7	29,0	28,I	24,9	27.6	1.2
13	910	29,3	28,9	29,9	32,8	32,5	32,3	3I,I	30,I	29,3	27,3	30.4	1.8
14	983	32,2	32,6	33,4	34,4	37,I	34,6	36,6	34,4	33,2	30,5	34.0	1.8
15	1020	3I,0	3I,2	32,2	33,5	32,0	32,7	32,7	3I,5	30,3	27,9	31.5	1.6

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 11 h. 50 min. No. Field IX Crop oak woods

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No. channel	λ-effect (nm)	Reflection coefficient (%) I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	I,9	I,8	I,7	I,8	I,7	I,7	2,0	I,8	I,9	I,6	1.8	0.1
2	438	2,I	2,2	2,I	2,2	23	2,I	2,2	I,8	2,I	I,9	2.1	0.1
3	500	2,8	2,8	2,2	2,7	2,7	2,0	2,2	2,2	2,2	2,2	2.4	0.3
4	530	4,2	4,2	4,2	4,3	4,5	4,0	4,6	3,7	4,0	4,0	4.2	0.3
5	560	5,4	5,4	5,0	5,6	5,6	5,0	5,0	4,8	5,0	4,8	5.2	0.3
6	582	4,9	4,6	4,4	4,6	5,I	4,6	4,4	4,2	4,0	3,8	4.5	0.4
7	729	3,7	3,7	4,2	3,7	4,5	3,7	3,7	3,7	3,7	3,7	3.8	0.3
8	657	I,7	2,7	2,3	2,3	2,3	2,3	I,9	2,3	I,9	I,9	2.2	0.3
9	682	4,2	4,I	4,I	4,5	4,I	3,8	3,8	4,I	3,8	3,8	4.0	0.2
10	728	28,8	27,2	27,8	30,6	3I,I	28,8	29,4	26,6	26,I	25,6	28.2	1.9
11	755	35,7	36,0	37,8	29,6	38,6	35,7	40,0	33,0	34,2	33,6	35.4	3.0
12	866												
13	910	36,4	35,8	40,0	4I,0	37,4	34,8	40,8	33,6	33,8	34,0	36.8	2.9
14	983	33,6	35,4	36,0	39,0	37,0	34,I	39,0	33,0	36,5	33,6	35.4	2.6
15	1020	35,4	36,2	36,2	37,7	36,2	35,4	37,7	30,0	33,1	33,I	35.1	2.4

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FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 11 h. 30 min. No. Field XIV Crop mowable steppe

No. channel	λ-effect (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	2,0	I,8	I,8	I,7	2,0	2,0	I,9	I,8	I,8	I,8	1.9	0.1
2	438	2,3	2,0	I,9	2,0	2,I	2,2	2,I	2,I	2,I	I,9	2.1	0.1
3	500	3,6	3,7	3,6	3,6	3,6	3,7	3,9	3,3	3,6	3,3	3.6	0.2
4	530	5,6	5,2	5,5	5,6	5,5	5,8	5,3	5,6	5,2	5,3	5.5	0.2
5	560	7,I	6,7	6,5	6,9	6,9	7,I	6,9	6,7	6,3	6,3	6.7	0.3
6	582	7,0	6,3	6,0	6,5	6,3	7,0	7,2	6,5	6,3	6,5	6.6	0.4
7	629	6,3	6,I	6,I	6,3	6,0	6,8	6,3	5,8	5,3	5,8	6.1	0.4
8	657	3,8	3,8	3,5	3,I	3,I	3,5	3,5	3,I	2,7	3,I	3.3	0.4
9	682	5,2	6,2	6,2	6,2	6,9	7,2	6,6	6,2	6,2	6,2	6.3	0.5
10	728	33,9	26,0	26,6	25,5	25,5	24,4	24,4	26,6	25,0	25,5	26.3	2.8
11	755	34,8	3I,8	3I,8	3I,8	3I,8	29,6	30,8	30,4	29,6	33,4	3[illegible].6	1.6
12	866	33,6	3I,4	33,9	3I,8	3I,4	29,6	3I,4	30,5	30,0	33,5	31.7	1.5
13	910	32,I	32,0	32,0	33,3	33,3	30,2	32,2	33,4	32,2	35,7	32.6	1.4
14	983	30,0	3I,3	32,0	32,5	32,5	30,8	3I,3	32,0	30,8	32,5	31.6	0.9
15	1020	30,8	36,8	33,0	32,3	30,7	30,7	30,7	30,7	30,7	32,3	31.9	1.9

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 11 h. 40 min. No. Field XIII Crop unmowable steppe

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	I,9	I,9	I,9	I,9	2,I	I,9	I,6	I,9	I,9	I,6	1.9	0.2
2	438	2,4	2,I	2,I	2,3	2,3	2,3	I,9	2,I	2,I	2,I	2.2	0.1
3	500	3,7	3,I	3,9	3,4	3,7	3,4	3,3	3,4	3,I	3,3	3.4	0.3
4	530	4,8	5,2	5,3	5,6	5,6	5,3	5,2	5,6	5,3	4,8	5.3	0.3
5	560	6,9	6,2	6,2	6,7	6,7	6,7	6,2	5,8	6,2	6,2	6.4	0.3
6	582	6,7	6,7	6,3	6,5	6,7	6,3	6,3	6,0	6,0	6,3	6.4	0.3
7	629	7,4	6,3	5,8	5,8	5,8	5,0	5,8	5,8	5,5	5,5	5.9	0.6
8	657	3,5	3,5	3,I	3,5	3,5	2,7	3,I	3,I	3,5	3,5	3.3	0.3
9	682	6,6	5,9	5,5	6,2	5,9	4,8	6,6	6,2	5,9	6,2	6.0	0.5
10	728	25,0	22,8	25,0	26,I	24,4	26,7	23,9	24,4	22,8	22,8	24.4	1.4
11	755	29,I	27,8	30,4	33,5	32,2	38,3	30,0	28,4	27,8	28,3	30.6	3.3
12	866	30,7	3I,4	3I,8	33,9	33,2	37,5	3I,4	29,3	27,9	28,6	31.6	2.8
13	910	30,5	3I,9	30,5	36,7	34,0	39,0	3I,0	3I,2	29,3	28,8	32.3	3.3
14	983	3I,3	27,5	29,7	32,8	30,6	36,6	29,7	30,6	28,4	27,5	30.5	2.7
15	1020	30,8	30,0	3I,5	32,3	3I,5	35,4	30,8	30,0	27,7	27,7	30.9	2.2

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 10 h. 00 min. No. Field III Crop corn

No. channel	λ-effect. (nm)	Reflection coefficient										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,8	2,7	2,4	2,9	2,7	2,6	2,6	2,6	2,3	2,6	2.6	0.2
2	438	3,0	3,0	2,8	3,I	3,0	3,I	3,0	3,0	2,9	2,9	3.0	0.1
3	500	3,6	3,8	3,5	3,5	3,5	4,I	3,5	3,9	3,8	4,0	3.7	0.2
4	530	4,I	3,8	3,9	3,9	4,0	3,9	4,3	4,2	4,3	4,0	4.0	0.2
5	560	4,5	4,5	4,4	4,6	4,6	4,6	4,7	4,4	4,7	4,5	4.6	0.1
6	582	4,9	4,3	4,3	4,6	4,5	4,5	4,8	4,2	4,6	4,2	4.5	0.2
7	629	4,3	4,4	4,2	4,3	4,3	4,3	4,4	4,I	4,I	4,5	4.3	0.1
8	657	4,I	4,I	4,I	4,2	4,5	4,I	5,3	4,I	4,5	4,9	4.4	0.4
9	682	4,6	4,6	4,3	4,I	4,3	4,3	4,7	4,0	4,3	4,6	4.4	0.2
10	728	I2,I	II,6	I3,7	I3,7	I3,7	I2,9	I3,7	I4,9	I4,I	I2,9	13.3	1.0
11	755	I3,6	I4,7	I7,6	I5,8	I8,I	I6,4	I6,0	I6,9	I6,9	I6,4	16.2	1.3
12	866	I4,8	I5,4	I7,2	I6,0	I7,7	I6,8	I6,2	I7,5	I7,9	I7,2	16.7	1.0
13	910	I4,6	I4,3	I5,6	I5,3	I5,6	I5,I	I5,6	I6,6	I6,3	I5,I	15.4	0.7
14	983	I7,5	I7,4	I8,6	I8,3	I8,6	I8,2	I8,5	I9,5	I9,5	I8,3	18.4	0.7
15	1020	20,0	20,5	2I,4	2I,4	2I,6	2I,0	22,3	23,7	22,6	2I,8	21.6	1.1

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 9 h. 40 min. No. Field VI' Crop spring wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,3	2,5	2,2	I,8	2,5	2,6	2,5	2,3	2,5	2,9	2.4	0.3
2	438	2,7	2,6	2,6	2,4	2,6	2,7	2,7	2,6	2,7	2,3	2.6	0.1
3	500	3,I	3,0	2,8	2,9	3,0	3,2	3,2	3,2	3,0	2,7	3.0	0.2
4	530	3,6	3,5	3,4	3,4	3,7	3,7	3,7	3,4	3,4	3,2	3.5	0.2
5	560	3,9	3,9	4,0	3,7	3,9	4,0	4,3	3,7	3,9	3,7	3.9	0.2
6	582	2,8	2,7	2,8	2,9	2,8	3,0	3,0	2,8	2,9	2,6	2.8	0.1
7	629	2,8	2,7	2,7	2,8	2,8	3,I	2,8	2,8	2,8	2,7	2.8	0.1
8	657	2,4	I,8	2,0	2,2	2,2	2,2	I,6	2,7	2,4	I,8	2.1	0.3
9	682	2,6	2,6	2,8	2,5	2,6	2,7	3,0	2,9	2,6	2,6	2.7	0.2
10	728	I5,C	I8,5	I5,0	I3,5	I5,0	I5,0	I5,6	I5,0	I2,I	I3,5	14.9	1.7
11	755	26,9	23,2	20,7	2I,4	I2,5	24,5	23,2	22,5	23,2	23,2	22.8	2.0
12	866	28,7	26,0	26,3	20,5	24,6	25,8	27,I	26,0	25,2	24,8	26.1	1.2
13	910	27,5	25,9	28,8	24,7	25,7	26,6	27,I	27,I	25,9	24,0	26.3	1.3
14	983	27,8	25,8	28,5	27,0	28,5	27,0	26,5	26	26	25,0	26.5	1.0
15	1020	27,2	24,8	27,0	26,0	23,5	26,0	25,0	26	25	2I,0	25.2	1.8

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 9 h. 35 min. No. Field I Crop winter wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	10	mean	stand. deviat.
1	410	2,6	2,7	2,5	2,7	2,7	2,5	2,4	2,5	2,7	2,7	2.6	0.1
2	438	3,2	3,6	3,3	3,4	3,2	3,I	3,0	3,0	3,4	3,2	3.2	0.2
3	500	5,0	4,9	4,6	4,8	4,8	5,0	4,4	4,6	4,8	4,2	4.8	0.2
4	530	6,4	6,6	5,3	6,0	5,6	6,3	6,I	6,0	6,6	5,7	6.1	0.4
5	560	7,I	7,6	6,6	6,9	7,0	7,3	6,6	6,7	6,7	7,3	7.0	0.3
6	582	6,2	6,6	6,2	5,9	5,8	6,0	5,7	5,6	6,0	5,4	5.9	0.3
7	629	5,6	6,3	5,8	5,7	5,5	5,8	5,4	5,4	5,8	5,0	5.6	0.3
8	657	6,4	5,5	6,5	5,5	5,3	6,0	5,3	4,8	6,0	4,3	5.6	0.7
9	682	5,6	5,6	4,8	5,I	5,I	5,4	5,0	4,8	5,0	4,6	5.1	0.3
10	728	2I	23,6	26,5	23,5	20,5	22,4	I9,8	2I,8	2I,8	I8,6	22.0	2.2
11	755	27	29,0	28,0	28,5	29,0	28,0	25,0	28,0	29,5	25,0	27.7	1.6
12	866	3I	32,3	3I,0	3I,5	3I,0	3I,0	28,0	30,0	33,0	29,0	31.1	2.1
13	910	32	35,7	3I,0	33,0	32,0	3I,5	29,0	30,0	24,0	3I,0	31.9	1.9
14	983	33	29,8	29,5	3I,5	29,5	30,0	27,5	29,0	32,0	30,0	30.2	1.6
15	1020	32	3I,7	28,0	29,5	28,0	28,5	26,5	29,0	3I,0	26,5	29.0	2.1

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 23 July 1976 Time 9 h. 20 min. No. Field VIII' Crop clover

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	2,6	2,I	2,6	2,3	2,4	2,4	2,I	2,3	2,4	2,3	2.4	0.2
2	438	2,8	2,8	2,6	2,5	2,7	3,I	2,7	2,8	2,7	2,8	2.8	0.2
3	500	3,0	3,3	2,9	2,8	3,3	4,0	3,3	3,3	3,3	3,6	3.3	0.3
4	530	4,0	3,3	2,5	3,7	3,8	3,5	4,0	4,0	3,8	3,9	3.7	0.5
5	560	3,9	4,2	4,I	3,8	4,3	4,0	4,0	4,3	4,4	4,3	4.1	0.2
6	582	2,9	2,9	2,9	2,9	2,9	2,9	3,0	3,I	3,2	3,I	3.0	0.1
7	629	2,8	2,8	4,0	2,8	3,0	2,9	3,0	3,I	3,3	3,2	3.1	0.4
8	657	2,8	2,8	2,5	2,8	2,5	3,I	2,2	3,I	2,8	3,I	2.8	0.3
9	682	3,I	2,9	3,I	3,I	3,I	2,7	2,9	3,0	3,I	2,9	3.0	0.1
10	728	20,2	I6,5	25,6	2I,2	2I,9	I9,2	I7,3	2I,9	20,2	2I,2	20.5	2.6
11	755	27,5	26,6	28,6	29,0	27,5	25,I	25,8	25,I	30,7	30,7	27.5	2.1
12	866	30,8	30,8	3I,4	3I,9	30,8	29,8	30,2	29,8	32,7	33,7	31.2	1.3
13	910	3I,0	32,I	3I,4	3I,4	3I,8	30,8	30,8	34,0	33,7	34,0	32.1	1.3
14	983	32,8	30,9	32,8	3I,8	33,4	3I,8	35,5	34,4	34,I	32,5	33.0	1.4
15	1020	33,0	3I,5	35,0	32,0	33,0	32,5	32,5	34,9	34,I	34,I	33.1	1.0

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 14. h. 14 min. No. Field Crop fallow land

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	3,I	3,3	3,4	3,4	3,6	3,3	3,4	3,I	3,4	3,3	3.3	0.1
2	438	3,8	4,0	4,I	4,3	4,0	3,9	4,0	3,8	3,9	3,7	4.0	0.2
3	500	4,4	5,0	4,6	4,8	5,0	4,2	4,2	4,2	4,0	4,2	4.5	0.4
4	530	4,8	4,4	4,6	4,4	4,6	4,6	4,I	4,I	4,I	4,4	4.4	0.2
5	560	5,4	5,7	5,3	5,5	5,5	5,4	5,0	5,0	5,2	5,3	5.3	0.2
6	582	5,8	6,I	5,8	6,5	6,I	5,9	5,5	5,5	5,5	5,9	5.9	0.3
7	629	6,8	6,3	6,I	6,8	6,8	6,9	5,7	5,7	6,3	6,3	6.3	0.4
8	657	7,7	7,2	7,2	8,2	8,2	7,2	6,7	6,3	7,2	6,7	7.3	0.6
9	682	I0,0	I0,8	I0,5	II,0	I0,5	I0,0	9,3	9,I	9,3	9,8	10.0	0.7
10	728	I0,5	I2,0	I0,9	I2,0	I0,9	I0,9	9,8	I0,4	I0,9	I0,4	10.9	0.7
11	755	I0,6	I2,5	I0,8	I2,2	II,7	I0,8	9,9	9,9	9,9	I0,8	10.9	0.9
12	866	I2,4	I3,5	I2,4	I4,0	I3,3	I2,3	I2,0	II,4	I2,3	I2,I	12.6	0.8
13	910	I3,4	I3,6	I2,7	I3,6	I3,6	I2,3	I2,3	II,0	II,4	I2,7	12.7	0.9
14	983	I4,3	I4,5	I5,0	I7,0	I5,6	I4,3	I3,6	I4,9	I5,0	I4,3	14.9	0.9
15	1020												

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 12 h. 58 min. No. Field IV Crop corn

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		1	2	3	4	5	6	7	8	9	10		
1	410	2,1	1,9	1,9	2,1	2,1	2,1	2,0	2,1	2,1	1,9	2.0	0.1
2	438	2,1	2,1	2,1	2,2	2,1	2,2	2,1	2,1	2,0	2,1	2.1	0.1
3	500	3,1	3,0	3,1	3,2	3,4	3,2	3,0	3,1	3,1	3,3	3.1	0.2
4	530	4,5	4,3	4,7	4,8	4,5	4,8	4,7	4,6	3,5	4,6	4.6	0.3
5	560	5,3	5,4	5,6	5,8	5,5	5,7	5,4	5,5	5,2	5,4	5.5	0.2
6	582	5,0	5,0	5,2	5,7	5,0	5,2	5,1	5,0	4,8	5,5	5.1	0.2
7	622	3,7	4,3	3,7	4,2	4,0	4,0	4,0	4,1	4,0	4,5	4.1	0.3
8	657	3,1	3,5	3,9	4,1	3,6	3,6	4,1	3,9	3,5	3,9	3.8	0.2
9	682	4,8	4,6	5,0	5,3	5,1	5,1	5,1	4,8	4,6	4,8	4.8	0.3
10	728	21,0	21,0	22,2	23,8	22,6	22,1	21,3	22,2	20,2	21,4	21.3	1.2
11	755	36,6	34,6	38,0	40,9	41,2	38,8	35,6	37,1	35,0	35,0	37.0	2.0
12	866	39,2	36,3	38,2	43,5	43,4	42,7	39,5	40,3	37,3	39,5	39.7	2.2
13	910	40,4	38,2	40,4	42,9	44,2	43,2	39,5	41,0	38,1	39,1	39.9	2.2
14	983	40,7	38,5	40,7	45,7	44,3	42,0	38,5	40,7	37,9	40,1	39.9	2.1
15	1020	39,6	37,7	40,7	43,5	44,7	41,6	39,8	41,0	37,9	37,9	39.4	2.4

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 14 h. 16 min. No. Field V Crop spring wheat

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		1	2	3	4	5	6	7	8	9	10		
1	410	2,0	2,0	2,3	2,3	2,4	2,0	2,0	2,3	2,0	2,1	2.2	0.2
2	438	2,3	2,2	2,0	2,2	2,2	1,8	1,8	2,0	2,3	2,2	2.2	0.1
3	500	4,8	4,8	4,1	4,3	4,6	3,9	4,0	4,2	4,4	4,7	4.3	0.3
4	530	5,5	4,8	5,0	5,2	5,7	4,3	4,3	4,8	5,0	5,3	4.9	0.4
5	560	6,4	6,7	6,4	6,1	7,1	5,4	6,3	6,1	6,6	6,7	6.4	0.3
6	582	7,2	7,9	6,9	6,7	7,8	6,4	6,4	6,6	7,1	7,4	7.0	0.4
7	622	8,0	8,6	7,55	7,5	7,8	7,0	7,1	6,7	7,5	7,9	7.5	0.5
8	657	10,1	10,6	9,6	8,5	9,6	8,5	8,1	8,6	8,6	8,7	8.9	0.7
9	682	14,4	13,9	12,5	12,3	13,9	11,1	11,4	11,0	12,5	13,6	12.5	1.0
10	728	18,9	17,7	17,7	17,2	19,6	16,5	18,5	16,5	18,5	17,7	17.8	1.1
11	755	20,0	18,9	18,9	18,9	21,4	18,9	21,0	18,8	20,0	19,2	19.8	1.1
12	866	22,4	21,2	20,9	21,5	23,6	21,5	21,9	20,1	22,4	22,3	21.7	1.5
13	910	23,8	22,4	21,4	21,4	23,8	20,9	21,0	20,0	23,0	23,3	21.6	1.5
14	983	24,5	23,8	23,1	22,2	26,2	24,5	23,5	23,6	24,3	24,6	24.2	1.4
15	1020	37,1	37,9	32,2	33,7	35,6	31,2	31,7	30,8	34,4	34,2	34.3	2.4

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 12 h. 40 min. No. Field VII Crop clover

No. channel	λ-effect. (nm)	Reflection coefficient (%)											
		I	2	3	4	5	6	7	8	9	I0	mean	stand. deviat.
1	410	2,0	I,9	I,9	2,0	I,9	I,9	I,9	I,9	I,9	I,9	1.9	0.1
2	438	I,8	2,0	2,0	2,0	2,0	I,9	2,0	2,0	2,0	I,9	1.9	0.1
3	500	2,9	2,9	2,7	2,7	2,9	2,7	2,7	2,6	2,6	2,7	2.7	0.2
4	530	4,0	3,9	4,2	4,0	4,0	4,0	4,0	4,0	3,9	4,2	4.1	0.2
5	560	4,2	4,8	4,7	4,6	4,5	4,9	4,8	4,5	4,5	4,5	4.6	0.1
6	582	4,4	4,4	4,3	4,3	4,I	4,3	4,4	4,2	4,I	4,I	4.2	0.2
7	622	3,9	3,4	3,7	3,4	3,6	3,6	3,7	3,7	3,2	3,7	3.6	0.2
8	657	3,6	3,6	3,3	3,3	3,3	3,3	3,3	3,3	3,6	3,6	3.5	0.3
9	682	4,6	4,6	4,0	4,6	3,7	4,2	4,4	4,4	4,4	4,2	4.4	0.2
10	728	22,7	24,3	25,0	23,9	24,6	24,3	24,3	24,3	23,9	23,5	23.5	1.1
11	755	34,2	36,0	35,8	37,4	36,I	36,8	37,4	36,I	38,9	38,5	34.6	1.6
12	866	37,6	39	39,2	39,3	39,3	39,8	40,0	39,3	38,9	37,8	34.3	2.4
13	910	38,3	40,5	39,3	40,8	40,0	39,9	40,8	42,I	38,3	38,7	38.2	2.0
14	983	40,0	4I,I	39,5	40,6	39,5	4I,I	42,2	4I,I	38,5	38,5	39.5	1.5
15	1020	39,7	4I,3	37,9	39,7	38,0	40,2	40,2	4I,3	37,4	38,0	38.9	1.6

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 14 h. 06 min. No. Field IX Crop oak woods

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,5	2,2	2,0	2,2	2,I	2,2	2,4	2,5	2,I	2,I	2.2	0.2
2	438	2,2	2,2	2,0	I,9	2,0	2,I	2,2	2,0	2,0	2,0	2.1	0.1
3	500	3,3	3,7	2,7	2,8	2,7	3,0	2,8	3,I	3,0	2,9	3.0	0.3
4	530	3,9	4,5	3,7	3,5	3,5	3,5	4,I	4,I	3,3	3,2	3.7	0.4
5	560	4,3	5,3	4,6	4,3	4,3	4,8	5,2	4,8	4,2	4,4	4.6	0.4
6	582	5,I	5,2	4,3	3,8	3,8	4,8	5,2	4,6	4,6	4,6	4.6	0.5
7	629	4,I	4,5	4,0	3,6	3,6	4,0	4,3	4,3	3,6	4,0	4.0	0.3
8	657	3,6	4,6	4,I	4,I	4,I	4,I	4,6	4,I	4,I	4,I	4.2	0.3
9	682	5,2	6,5	5,2	4,9	4,9	5,2	6,0	5,2	5,2	5,4	5.4	0.5
10	728	I2,7	2I,6	I6,9	I8,5	I8,5	I7,4	2I,4	I8,5	I9,I	I9,3	19.1	1.6
11	755	26,6	28,I	23,2	25,2	25,2	23,7	28,I	25,6	27,0	26,7	26.0	1.7
12	866	30,0	3I,2	26,2	27,8	27,8	26,7	32,6	30,0	29,I	29,3	29.1	2.0
13	910	28,I	29,9	26,9	26,3	26,3	26,3	33,9	29,4	28,5	28,4	28.4	2.8
14	983	28,3	34,3	26,I	26,8	26,8	28,3	33,5	3I,3	29,I	28,9	29.3	2.8
15	1020	3I,2	35,I	28,I	26,3	26,6	28,3	33,0	32,7	29,6	30,I	30.2	2.7

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 11 h. 45 min. No. Field VIII" Crop clover

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	I,9	2,I	2,0	2,0	I,9	2,0	I,7	2,I	I,8	I,7	1.9	0.1
2	438	I,9	I,7	I,9	I,9	I,9	I,8	I,9	I,8	I,8	I,8	1.9	0.1
3	500	2,7	2,8	2,9	2,7	2,7	2,9	2,7	2,8	2,9	2,7	2.8	0.2
4	530	4,2	3,8	4,I	4,3	4,3	4,3	4,3	4,0	4,0	4,0	4.1	0.2
5	560	5,3	5,I	4,8	5,2	4,6	4,8	4,9	4,9	5,0	4,8	5.0	0.2
6	582	4,5	5,0	4,5	4,4	4,7	4,6	4,4	4,5	4,2	4,5	4.5	0.2
7	622	4,I	4,I	3,6	3,6	3,6	3,8	3,8	3,3	3,8	3,4	3.7	0.2
8	657	3,7	3,6	3,5	3,8	3,8	3,8	3,8	4,4	3,5	3,5	3.7	0.2
9	682	4,6	4,6	4,4	4,4	4,4	4,4	4,0	4,I	4,I	4,I	4.4	0.2
10	728	2I,I	22,0	22,4	20,8	2I,7	2I,4	20,6	20,6	I9,9	20,3	21.2	1.0
11	755	29,4	3I,0	3I,0	30,2	3I,0	30,2	29,4	29,9	28,9	29,4	29.9	1.3
12	866	29,9	32,6	33,I	3I,I	30,8	3I,2	30,9	3I,I	29,7	29,8	30.9	1.4
13	910	29,2	32,I	33,2	3I,I	32,4	3I,6	30,6	30,6	30,8	29,2	31.1	1.3
14	983	35,6	33,8	36,8	32,6	33,4	34,2	34,2	32,6	33,5	30,5	33.4	1.5
15	1020	32,9	35,6	36,5	33,9	34,3	33,9	34,3	33,5	34,3	32,6	33.8	1.3

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 6 September 1976 Time 12 h. 25 min. No. Field III Crop corn

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,I	2,I	2,2	2,I	2,I	2,I	2,0	2,I	2,0	2,I	2.1	0.1
2	438	2,3	2,3	2,4	2,I	2,2	2,2	2,3	2,I	2,2	2,3	2.2	0.1
3	500	3,6	3,5	3,4	3,I	3,5	3,4	3,I	3,2	3,7	3,2	3.4	0.2
4	530	5,4	4,9	5,I	5,I	4,7	4,7	4,7	4,6	5,3	5,3	5.1	0.3
5	560	6,5	6,5	6,I	5,9	5,8	5,7	5,6	5,8	6,I	5,9	6.1	0.2
6	582	6,4	5,9	5,5	5,4	5,2	5,2	5,4	5,2	6,I	6,2	5.8	0.3
7	622	5,2	5,0	4,8	4,5	4,5	4,5	4,7	4,8	4,9	4,5	4.7	0.3
8	657	5,0	5,0	5,0	4,6	4,6	4,2	4,6	4,6	4,7	4,2	4.6	0.3
9	682	5,6	5,6	5,2	5,0	5,6	5,2	5,4	5,2	5,9	5,5	5.6	0.3
10	728	26,6	23,0	23,0	22,6	22,3	2I,9	2I,9	2I,9	24,9	23,9	22.9	1.0
11	755	37,6	35,0	35,0	35,0	36,4	34,4	34,7	34,7	38,4	38,4	36.2	1.4
12	866	39,5	36,7	38,2	37,I	37,4	36,5	36,6	36,2	40,2	40,0	38.2	1.4
13	910	38,9	38,6	36,8	34,8	38,8	35,3	36,5	34,5	39,5	40,6	38.0	1.4
14	983	39,0	39,5	36,8	37,9	36,8	37,9	35,8	36,9	40,3	4I,5	39.4	1.7
15	1020	4I,0	42,I	38,2	38,2	38,2	37,I	37,I	35,5	4I,2	43,2	39.8	1.7

FIELD SPECTROMETRIC MEASUREMENTS

Mission Date 9 September 1976 Time 14 h. 00 min. No. Field XIV Crop mowable steppe

No. channel	λ-effect. (nm)	Reflection coefficient (%)										mean	stand. deviat.
		I	2	3	4	5	6	7	8	9	I0		
1	410	2,2	2,2	2,3	2,2	2,0	2,I	2,2	2,0	2,0	2,2	2.1	0.1
2	438	2,3	2,2	2,0	2,3	2,0	2,0	2,2	2,0	2,0	2,2	2.2	0.2
3	500	3,4	3,6	3,8	3,6	3,3	3,5	3,5	3,2	3,2	3,3	3.4	0.2
4	530	5,4	5,4	4,7	5,3	4,7	4,8	4,8	4,7	4,8	5,3	5.0	0.3
5	560	6,6	6,2	6,2	6,4	5,5	5,7	6,2	5,7	5,9	6,4	6.2	0.3
6	582	6,0	6,2	6,I	5,5	5,6	5,3	5,8	5,5	5,5	5,5	5.8	0.3
7	629	5,0	5,2	5,2	5,0	5,0	4,8	5,0	4,4	4,8	5,0	5.0	0.3
8	657	4,9	4,9	5,3	4,9	4,2	4,6	5,0	3,8	4,6	5,4	4.8	0.4
9	682	6,0	6,7	7,5	6,0	5,9	5,7	5,9	5,9	5;5	6,5	6.2	0.6
10	728	23,0	2I,8	I9,3	2I,4	I9,7	I8,9	20,4	22,5	2I,3	22,5	21.8	0.7
11	755	3I,5	26,8	2I,4	29,0	24,7	24,0	27,I	27,7	28,0	28,7	28.3	3.7
12	866	32,7	29,2	23,2	29,7	25,9	26,5	29,2	29,9	30,2	3I,2	29.8	3.1
13	910	32,6	29,5	28,7	30,5	27,I	26,8	29,7	30,4	3I,0	3I,3	30.7	3.2
14	983	34,9	33,I	26,6	34,3	29,5	29,5	3I,2	33,4	32,9	34,0	33.0	4.7
15	1020	39,I	35,9	32,9	34,7	32,6	32,6	34,3	34,9	37,3	36,7	35.9	2.4

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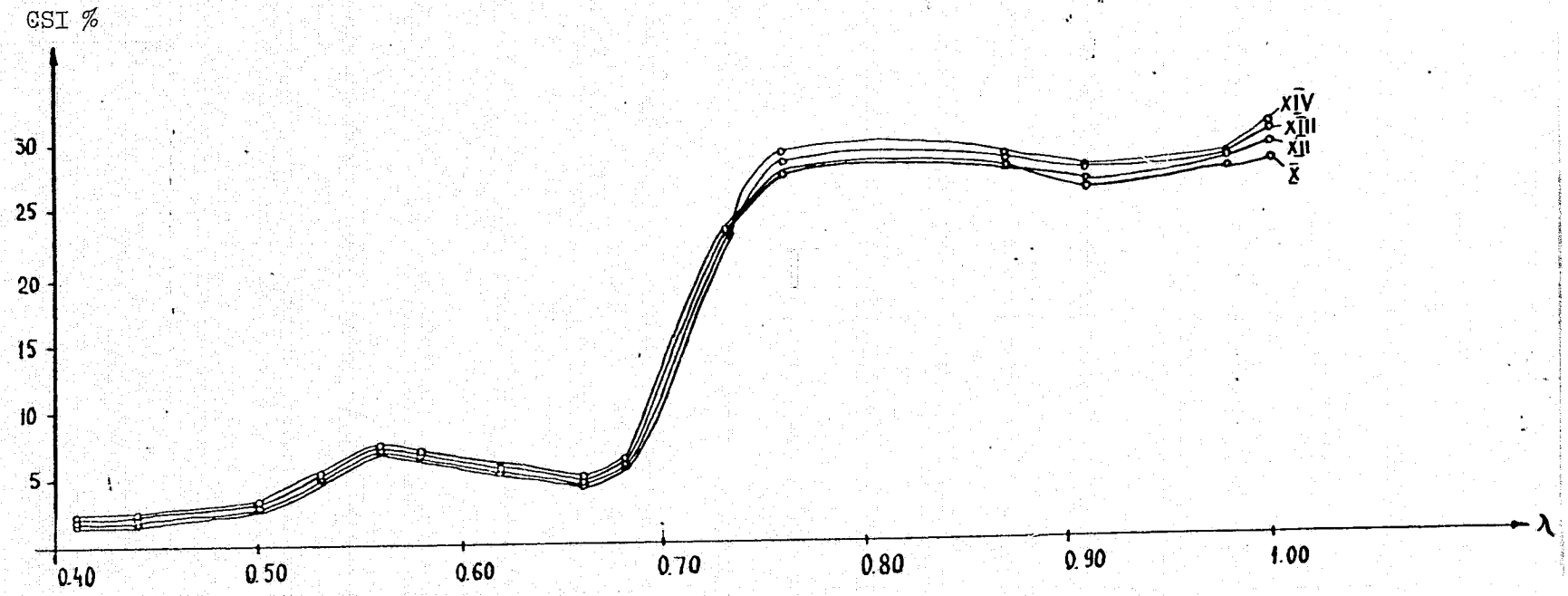
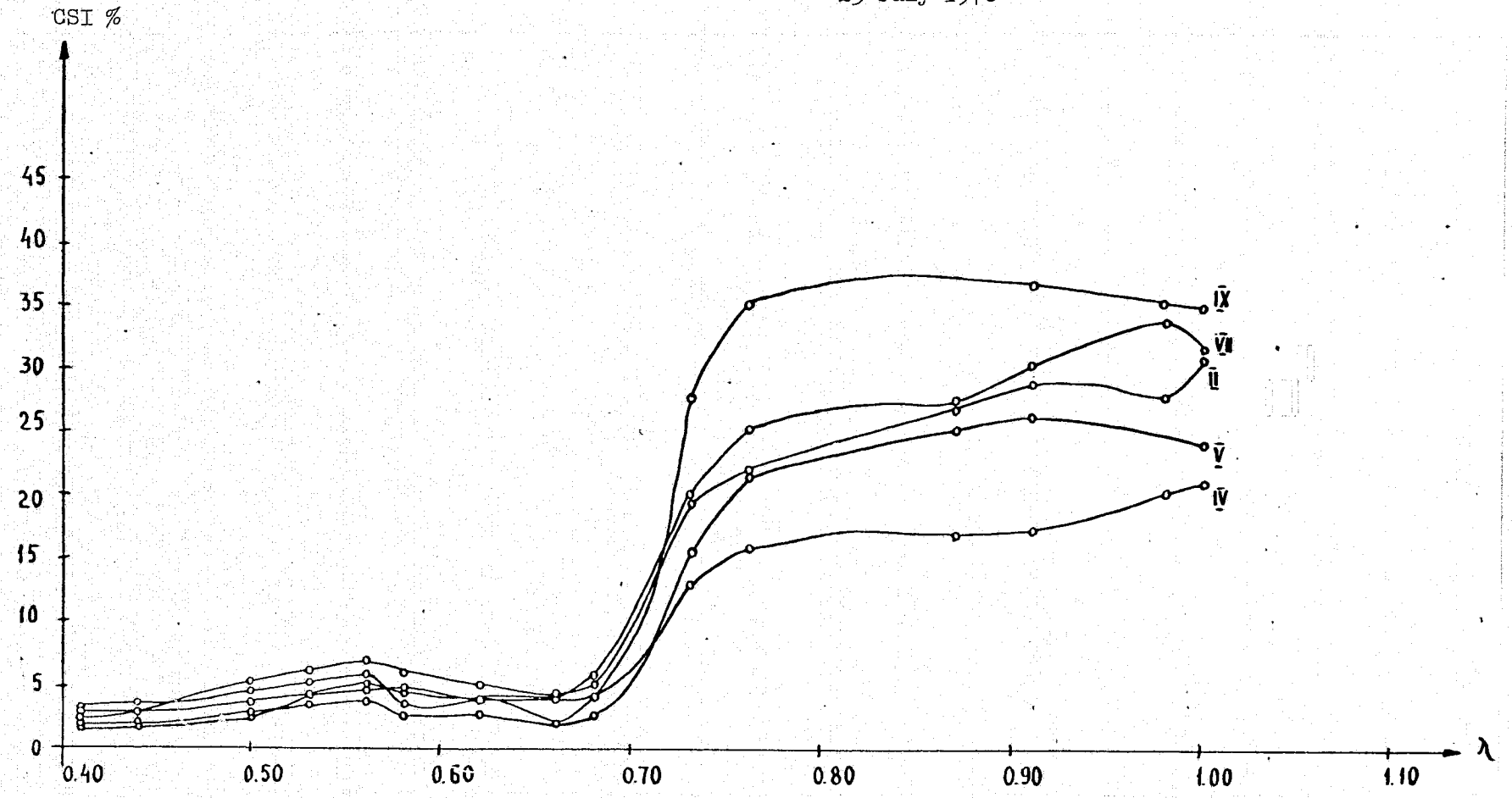
22 June 1976



23 July 1976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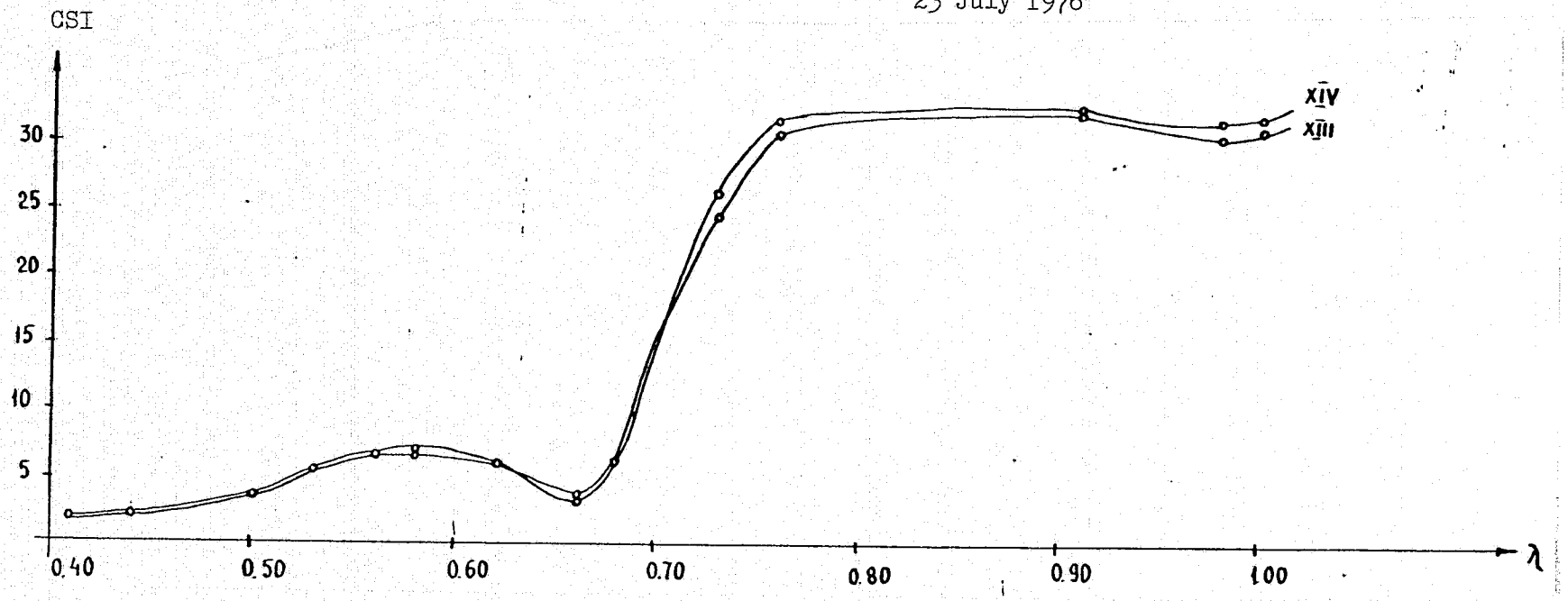
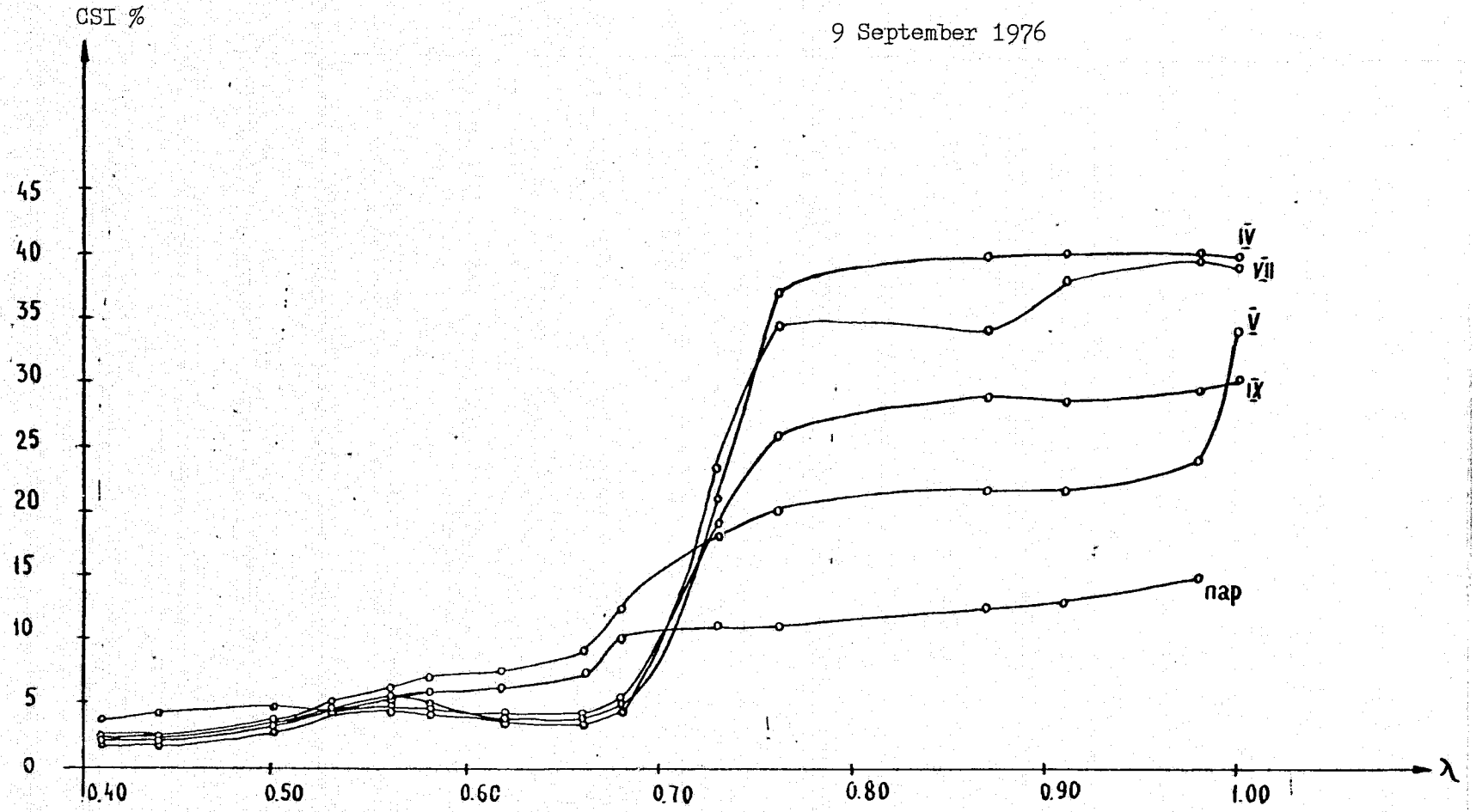
23 July 1976

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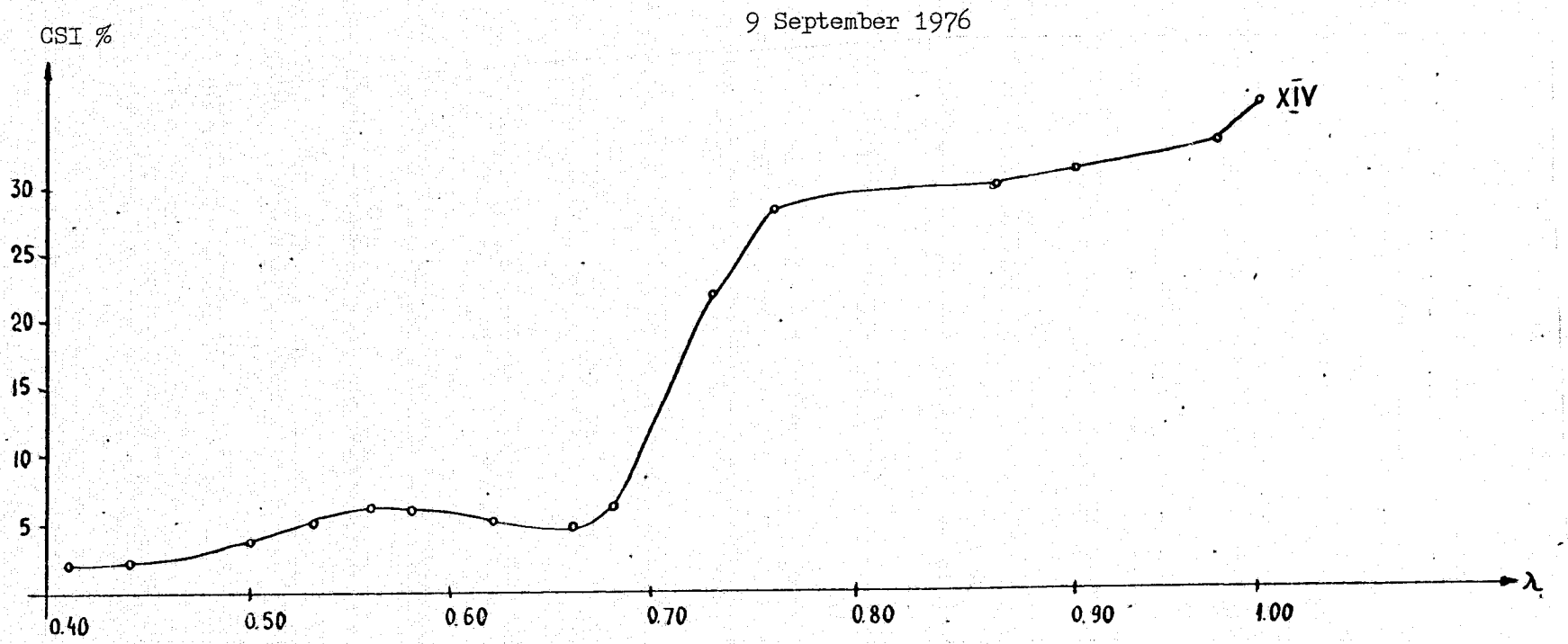
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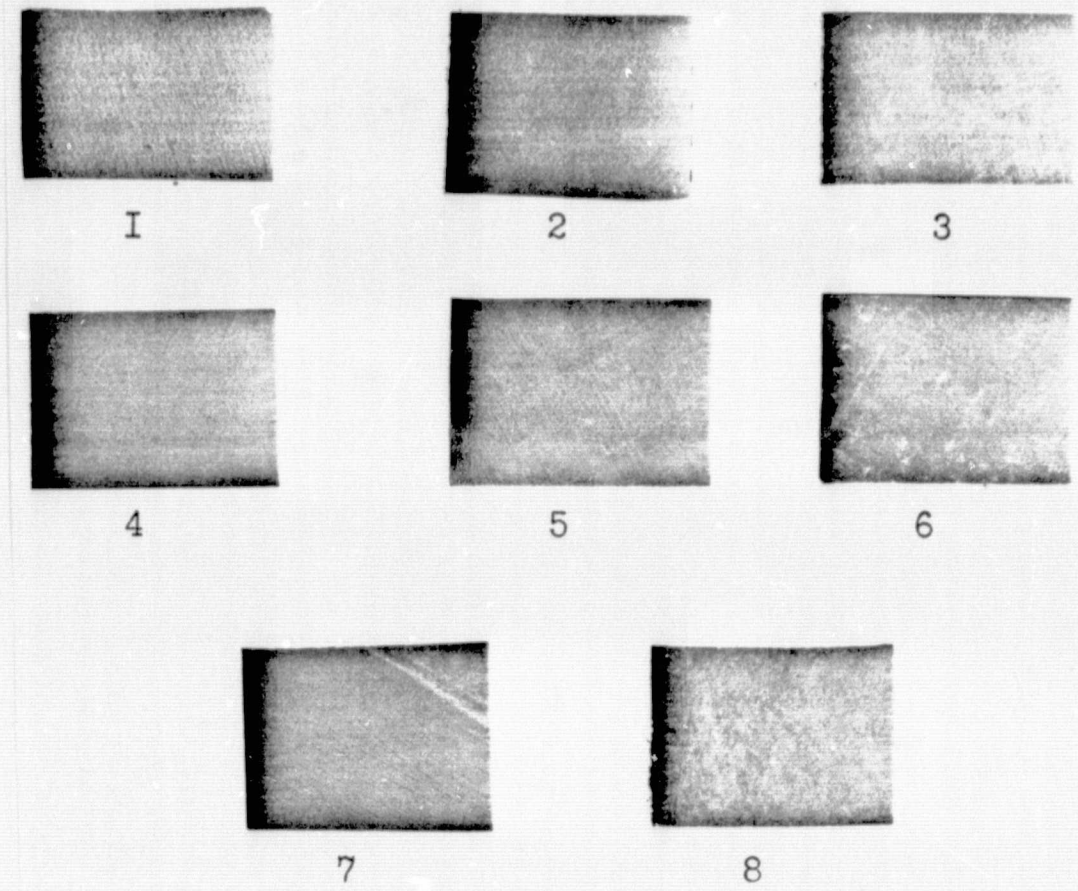
Photographs obtained synchronously with spectrometering. 24.7.76.



1--winter wheat, 2--clover, 3--steppe, 4--plowed field, 5--spring wheat, 6--clover, 7--plowed field, 8--steppe.

Appendix 3. /77

Materials of Ground Observations

Notes for table "Measurements of Dynamic Characteristics of Soils" /78

1. Requirements of preservation on natural ecosystems were determined by the minimum volume of work to evaluate soil moisture content.

The presence of a dense vegetation cover and waste in the steppe and woods generally casts doubt on the need for measuring soil moisture content here (as an index which could be possibly evaluated by a complex of remote-controlled resources used within the Soviet-American program).

2. Measurements of soil moisture content were made in 1976 to depths of 0, 10, 20, etc. Therefore the column "0-5 cm" gives information only about the surface moisture, while for other levels the soil moisture content was obtained by interpolation.

In 1977 at the Kursk site the soil moisture content will be measured during the missions at depths: 0.0, 5, 20 and 35 cm with ten-fold repetition. Information on the moisture in the layer 35-60 cm in virtue of its low variability both in space and time will be obtained from adjacent weather bureaus with an agricultural meteorological set of observations.

3. In the first mission it was possible to determine the subsurface soil moisture content only on supporting ecosystems.

MEASUREMENTS OF DYNAMIC CHARACTERISTICS OF SOILS /79

Mission I Date 24.6.76

Field No.	Color accord. to Mansell	Relative moisture by vert. %				Conditions on surface Notes
		0-3 cm	5-20 cm	20-35 cm	35-60 cm	
1	7.5.YR3/0	13.5	16.7	19.0	18.5	winter wheat
2	7.5.YR4/0	14.3	-	-	-	winter wheat
3	7.5.YR	9.0	-	-	-	corn
4	7.5.YR/4	7.2	19.3	20.4	20.2	corn
5	7.5.YR2/0	15.7	-	-	-	spring wheat
6	7.5.YR2/0	15.0	20.0	22.0	18.5	spring wheat
7	7.5.YR3/0	10.0	15.5	16.0	17.3	clover
8	7.5.YR3/0	11.3	-	-	-	clover
9	-	-	-	-	-	oak woods
10-11	7.5.R4/0	19,5	-	-	-	pasturable steppe
12 - 13	7.5.YR2/0	25.0	-	-	-	unmowable steppe
14-15	7.5.YR2/0	21.0	23.0	23.5	23.5	mowable steppe

MEASUREMENTS OF DYNAMIC CHARACTERISTICS OF SOILS /80

Mission 2 Date 21.7.76

Field No.	Color according to Mansell	Relative moisture by vert.%				Conditions on surface Notes
		0-3 cm	5-20 cm	20-35 cm	35-60 cm	
1	2.5Y3/0	34.2	23.6	18.9	17.0	winter wheat
2	2.5Y3/0	36.1	25.6	20.0	17.2	winter wheat
3	2.5Y4/0	29.5	27.2	23.5	-	corn
4	2.5Y3/0	37.2	37.5	35.4	23.0	corn
5	2.5Y3/0	33.4	30.5	28.1	21.1	spring wheat
6	2.5Y3/0	37.2	32.5	27.0	21.2	spring wheat
7	2.5Y4/0	35.6	32.2	28.5	22.4	clover 6 porous on mowed
		33.8	32.0	26.7	22.2	4-on unmowed clover
8′	2.5Y3/0	32.1	29.6	24.3	20.1	clover
8	2.5Y4/0	26.5	32.0	28.6	25.4	fallow land,packed,harrowed
14-15	2.5Y2/0	39.2	-	-	-	stubble field after mowing on mowable steppe
10-11		-	-	-	-	steppe pasturable
12-13	2.5Y2/0	44.0	-	-	-	steppe unmowable
14-15	2.5Y2/0	46.2	-	-	-	steppe mowable

MEASUREMENTS OF DYNAMIC CHARACTERISTICS OF SOILS /81

Mission 3 Date 18 August 1976

Field No.	Color according to Mansell	Relative moisture by vert. %				Conditions on surface Notes
		0-3 cm	5-20 cm	20-35 cm	35-60 cm	
1	2.5.Y4/0	17.4	31.4	30.8	21.2	winter wheat
2	2.5.Y4/0	18.2	31.6	32.0	20.8	winter wheat
3	2.5.Y3/0	23.4	30.1	28.6	24.3	corn
4	2.5.Y3/0	25.2	29.8	30.2	22.1	corn
5	2.5.Y3/0	20.8	27.4	28.8	24.2	spring wheat
6	2.5.Y3/0	21.2	30.9	30.7	26.1	spring wheat
7	2.5.Y3/0	24.5	24.7	25.6	19.4	clover
8'	2.5.Y3/0	23.9	26.1	24.4	18.3	clover
8	2.5.Y4/0	12.8	34.2	32.4	22.1	fallow land harrowed
12-13			35.4	32.2	23.0	steppe unmowable
14-15			34.7	31.9	21.0	steppe mowable

MEASUREMENTS OF DYNAMIC CHARACTERISTICS OF SOILS /82

Mission 4 Date 23.9.76

Field No.	Color according to Mansell	Relative moisture by vert. %				Conditions on surface
		0-3 cm	3-20 cm	20-35 cm	35-60 cm	
1	10 YR 2/1	4.5	27.5	28.7	23.6	fallow land med. and coarse lumpy on 17.9
2	10 YR 2/1	4.0	28.3	30.2	24.2	fallow land medium and coarse lumpy on 17.9
3	7.5 R 3/0	7.9	25.9	27.9	21.3	corn; harvest in progress
4	7.5 R 3/0	8.3	26.1	28.2	20.2	corn; harvest in progress
5	7.5 R 3/0	7.1	28.4	28.4	25.3	stubble field of spring wheat
6	7.5 R 3/0	7.4	28.9	26.1	23.5	stubble field of spring wheat
7	7.5 R 3/0	12.3	27.9	28.8	25.4	clover in eastern part mowed and growing up again
8		-	-	-	-	clover
10-11		-	-	-	-	plowable steppe
12-13		-	-	-	-	unmowable steppe
14-15		-	-	-	-	mowable steppe

MEASUREMENT OF STATISTICAL CHARACTERISTICS OF SOILS /83

Location of test section: Kursk preserve and Kursk experimental station

Date of measurement

Field No.	Types of soil	Texture			% humus of organic carbon	Color according to Mansell	Notes
		% sand 0.25-0.01	% silt	% clay 0.01 mm			
I	typical chernozem	44.9 43.2	28.0-27.6	47.1-48.2	8.01	7.5 YR3/	
II	"	43.2-41.0	25.0-26.0	56.8-59.0	8.79	7.5 YR3/	
III	"	43.2-45.1	56.8-54.9	56.8-54.9	7.89	7.5 YR4/	
IV	"	the same			7.90	7.5 YR 4	
V	"	44.9-43.2	28.0-27.6	47.1-48.2	8.01	7.5 R 3	
VI	"	the same			8.45	7.5 R 3	
VII	"	44.0-47.3	23.4-25.5	45.9-49.4	8.30	7.5 R 3	
VIII	"	the same			7.98	7.5 R 3	
XIV-XV	leached chernozem	47.5-48.2	25.7-26.4	45.0-43.8	9.86	7.5 YR 3	
XIII-XIII	leached chernozem	the same			9.45	7.5 YR 3	
XI	"	the same			8.97	7.5 YR 3	
IX	podsolized chernozem	44.0-47.3	23.5-25.5	45.9-49.4	8.15	7.5 YR 2	

LIST OF LANDS EMPLOYED

Test section Kursk Date 24.6.76, 21.7.76

Field No.	Area (ha)	Crop or lands	Variety of crop	Date of planting (sowing)	Fertilization of soil A P K	Note
I(6-P)	124	winter wheat	Mironovskaya-808	20-25 August	near fall plowing: 200 kg/ha nitroamophosk April 76. nitrogen supplements 150-200 kg/ha	In southern part of section winter rye
II(7-P)	76	winter wheat	Mironovskaya-808	20-25 August	the same	
III(5-P)	80	corn	Bukovinskaya + Odesskaya	1-5 May	Mar-Apr. 76: supplement 200-250 kg/ha nitroamophosk	on 21.7 in northern part crop damage from grazing cattle
IV(I-P)	111	corn	Bukovinskaya + Odesskaya	1-5 May	the same	
VI'(I-OPKh)	132	spring wheat	Khar'kovskaya-46	15-17 April	without fertilizers	leveling sowing: cut by mountain goat at end of May in phase of tubule emergence
V(1-Ts)	64.5	spring wheat	Khar'kovskaya-46	25-27 April	16.5 kg/ha 16.5 kg/ha 16.5 kg/ha nitroamophosk in rows	cut by mountain goat and treated with amine salt for lodging and weeds
VII(2-Ts)	94	clover	Makarovskiy	12-15 April 1975	200kg/ha 200 kg/ha 200 kg/ha nitroamophosk	clover on stubble field of cereals
VIII'(2-OPKh)	~200	clover	Makarovskiy	12-15 April 1975	without fertilizers	the same

LIST OF LANDS EMPLOYED

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Test section Kursk Date 18.8.76

No. of field	Area (ha)	Crop or lands	Variety of crop	Date of planting (sowing)	Fertilization of soil			Note
					A	P	K	
I(6-P)	124	winter wheat	-	-	-	-	-	In southern part there is a section of winter rye
II(7-P)	76	winter wheat	-	-	-	-	-	-
III(5-P)	80	corn	-	-	-	-	-	in northern section crop damage from grazing cattle
IV(1-P)	111	corn	-	-	-	-	-	-
VI(1-OPKh)	132	spring wheat	-	-	-	-	-	-
V(1-Ts)	64.5	spring wheat	-	-	-	-	-	-
VII (2-Ts)	94	clover	-	-	-	-	-	in eastern section lie swaths of mowed clover
VIII (2-OPKh)	~200	clover	-	-	-	-	-	-

LIST OF EMPLOYED LANDS

Test section Kursk Date 17.9.76, 23.9.76

Field No.	Area (ha)	Crop or lands	Variety of crop	Date of planting (sowing)	Fertilization of soil			Note
					A	P	K	
I(6-P)	124	fallow land	-	-	-	-	-	medium and coarse lumpy
II(7-P)	76	fallow land	-	-	-	-	-	medium and coarse lumpy
III(5-P)	80	corn + stubble	-	-	-	-	-	stubble in central part of field
IV(1-P)	111	corn + stubble	-	-	-	-	-	stubble in eastern part of field
VI'(1-OPKh)	132	stubble spring wheat	-	-	-	-	-	-
V(1-Ts)	64.5	stubble spring wheat	-	-	-	-	-	-
VII(2Ts)	94	clover	-	-	-	-	-	in eastern part sprouts after harvest
VIII'(2-OPKh)	~200	sowing of wheat	Lake Mironovskaya-808	10-15.9	without fertilizers			

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METEOROLOGICAL CONDITIONS DURING MISSION

Test section Kursk Mission 2 Date 24.6.76

Time, hours, minutes	Temperature °C	Relative humidity (%)	Atmospheric pressure (mbar)	Wind		Cloud cover	
				Velocity kph	Direction	H.L./ L.L.*	Type
6.00	12.4	82	98.8	3.5	NNE	2/0	Ac
9.00	17.6	62	98.8	11.0	NNE	0/0	-
12.00	20.7	41	98.9	3.5	N	7/7	Ci

*High level/low level

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METEOROLOGICAL CONDITIONS DURING MISSION

Test section Kursk Mission 3 Date 21.7.76

Time, hours, minutes	Temperature °C	Relative humidity	Atmospheric pressure (mbar)	Wind		Cloud cover	
				Velocity kph	Direction	%	Type
6.00	11.7	98	98.3	11.0	N	%	-
9.00	16.7	78	98.3	14.0	N	%	-
12.00	20.4	58	98.3	21.0	ENE	3/3	Ci

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METEOROLOGICAL CONDITIONS DURING MISSION

Test section Kursk Mission 4 Date 18.8.76

Time, hours, minutes	Temperature °C	Relative humidity	Atmospheric pressure (mbar)	Wind		Cloud cover	
				Velocity kph	Direction	H.L./ L.L.	Type
6.00	12.4	97	987	3.5	WNW	0/0	-
9.00	17.5	76	988	3.5	W	3/0	Ci, Ac
12.00	20.7	49	988	3.5	WNW	6/3	Ci,Ci

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METEOROLOGICAL CONDITIONS DURING MISSION

Test section Kursk Mission 5 Date 17.9.76

Time, hours, minutes	Temperature °C	Relative humidity (%)	Atmospheric pressure (mbar)	Wind		Cloud cover	
				Velocity kph	Direction	H.L./ L.L.	Type
6.00	8.3	83	988	11.0	ENE	5/0	Ci,Ac
9.00	12.4	7.3	988	11.0	NE	7/5	Ac,Sc
12.00	21.4	29	988	18.0	ESE	5/5	Ci

MEASUREMENT OF TEMPERATURE AND PRECIPITATION

Section Kursk Month June 1976

/91

Day of month	Temperature Max.	Min.	Aver.	Precipitation mm/day
I	22,9	I3,6	I6,8	0,6
2	I9,4	II,6	I5,I	7,2
3	I8,6	I3,5	I5,0	4,6
4	I5,3	II,5	I2,9	0,0
5	I7,6	II,2	I2,6	0,8
6	I6,5	9,5	II,8	I,6
7	I5,3	8,9	II,8	0,4
8	I9,3	II,5	I3,9	2,8
9	I4,2	6,8	9,8	
I0	I2,3	6,2	8,3	0,5
II	I7,5	8,0	I0,7	2,7
I2	I6,4	6,2	9,7	0,7
I3	I6,I	6,5	9,6	2,3
I4	I8,I	6,4	I2,3	2,4
I5	I9,9	9,5	I4,0	
I6	2I,5	I2,5	I4,2	3,3
I7	I6,5	9,2	II,2	4,6
I8	I9,I	9,2	I2,7	0,6
I9	20,7	8,4	I3,7	0,0
20	24,I	I0,4	I6,6	
2I	26,5	I4,3	20,6	
22	23,I	I6,0	I7,8	
23	2I,7	I3,5	I6,8	0,3
24	23,4	9,8	I6,3	
25	23,6	I0,2	I6,8	
26	25,0	I0,3	I8,2	
27	27,4	I3,7	20,8	
28	27,5	I6,I	23,4	
29	27,2	I7,2	20,0	0,0
30	I9,9	I0,0	I3,7	
3I				
Total	606.6	180.8	437.1	35.4
Mean	20.22	6.03	14.57	

MEASUREMENT OF TEMPERATURE AND PRECIPITATION

Section Kursk — Month July

Day of month	Temperature max.	Temperature min.	Temperature average	Precipitation mm/day
I	23,2	8,5	I4,4	3,9
2	I6,I	II,3	I2,7	2,2
3	I9,I	9,7	I2,7	0,5
4	20,6	I0,3	I4,2	2,4
5	I8,7	8,2	I2,8	0,0
6	I7,7	7,0	II,9	
7	I5,8	I0,0	II,7	0,0
8	I7,2	I0,2	I2,8	3,2
9	2I,5	9,4	I5,6	
I0	23,6	I0,4	I6,6	
II	23,9	I2,2	I8,6	
I2	23,6	I2,9	I7,6	7,8
I3	2I,0	I4,4	I5,9	5,6
I4	I9,9	I3,8	I6,I	I,I
I5	I6,7	I3,I	I4,4	8,8
I6	I7,7	I3,8	I4,5	0,0
I7	20,3	I0,5	I4,8	
I8	23,6	9,5	I6,5	
I9	22,7	I4,4	I6,3	I6,4
20	I9,8	I3,9	I6,6	I,2
2I	23,5	II,I	I7,0	
22	23,9	II,2	I8,6	
23	23,6	II,9	I7,2	0,3
24	24,5	I2,4	I8,0	
25	25,2	I3,9	I8,6	
26	27,0	I2,9	I9,9	
27	27,2	I6,5	2I,0	5,7
28	20,8	I6,9	I7,9	II,0
29	25,5	I5,3	20,0	0,0
30	22,I	I6,5	I7,7	59,4
3I	I9,4	I4,7	I6,I	8,9
Total	664.9	376.8	498.7	137.4
Mean	21.45	12.15	16.09	

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MEASUREMENT OF TEMPERATURE AND PRECIPITATION

Section Kursk Month August 1976

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Day of month	Temperature max.	min.	average	Precipitation mm/day
I	24,2	I2,9	I8,6	
2	25,4	I4,2	20,4	
3	20,5	I5,2	I6,9	49
4	I9,9	II,5	I3,9	0,3
5	24,6	I0,4	I7,0	
6	24,6	I0,2	I7,8	
7	I9,3	I4,2	I4,8	8,2
8	I5,5	I3,3	I3,8	I9,I
9	I5,5	II,9	I2,9	I0,2
I0	I7,5	II,5	I2,8	2,4
II	I7,7	I0,3	I2,8	I,5
I2	20,3	8,7	I4,2	
I3	I7,8	I0,I	I4,I	0,5
I4	2I,7	I0,0	I6,I	
I5	23,3	9,3	I6,4	
I6	25,0	II,9	I8,I	0,0
I7	23,4	I3,I	I7,4	
I8	23,5	II,9	I7,7	
I9	23,6	II,4	I8,3	
20	22,5	I2,9	I6,7	
2I	20,9	I0,9	I4,8	0,0
22	I4,4	7,7	9,8	0,0
23	I7,3	3,7	9,6	
24	I9,6	6,5	I2,9	
25	20,6	I0,8	I4,2	
26	24,0	8,9	I6,9	
27	24,4	II,6	I8,3	
28	2I,8	II,6	I5,3	
29	24,0	7,5	I5,6	
30	2I,7	I2,9	I6,4	
3I	22,9	I2,4	I5,9	
Total	657.4	339.4	480.4	47.1
Mean	21.21	10.95	15.50	

MEASUREMENT OF TEMPERATURE AND PRECIPITATION

Section Kursk Month September 1976

/94

Day of month	Temperature max.	min.	average	Precipitation mm/day
I	22,3	I3,4	I6,0	
2	I8,2	II,4	I3,4	
3	2I,2	II,4	I5,2	
4	2I,4	I0,6	I5,9	
5	22,I	8,6	I4,9	
6	I9,8	I3,4	I5,3	I8,4
7	I5,5	I0,7	I2,0	I8,7
8	I6,2	7,I	II,7	0,9
9	I6,7	9,7	I3,3	
I0	20,3	9,0	I3,8	
II	20,4	I0,4	I3,8	
I2	2I,4	8,2	I4,0	
I3	2I,I	9,3	I3,9	
I4	24,4	6,7	I3,6	
I5	22,3	8,8	I4,7	
I6	2I,9	8,I	I4,5	
I7	22,2	7,9	I4,0	0,0
I8	I9,2	6,9	I2,I	
I9	I4,0	8,9	I0,2	I,4
20	I3,5	5,5	8,0	
2I	I4,2	-0,I	6,4	
22	I4,4	-0,4	6,I	
23	I2,0	0,3	6,8	
24	II,6	3,7	7,0	
25	I2,8	6,2	8,3	0,9
26	I3,6	6,9	9,0	4,7
27	I0,0	4,6	6,4	I,7
28	II,5	I,9	6,4	
29	9,0	3,3	5,5	2,8
30	5,3	-I,I	I,I	
3I			-	-
Total	508.5	211.3	333.3	42.5
Mean	16.95	7.04	11.1	

BIOLOGICAL OBSERVATIONS AND MEASUREMENTS

Mission I

Date 23-25 June 1976

Field No.	Stage of vegetation	Height of plants(cm)	Protect. cover(%)	No.of stalks/ m^2	No. of ears/ m^2	Weight of dry bio-mass,g/m^2	Weight of dry biomass,%			Moisture of plants,%	Leaf index
							fallen leaves	stems	gener. organs		
I	heading	119	60	147	147	784	22/0	61	17	81	-
II	heading	125	81	163	163	853	16/6	66	12	82	-
III	sprouts	28	23	5.5	-	16.5	67/0	33	-	13	-
IV	sprouts	15	13	5.7	-	14.3	80/0	20	-	93	0.2
V	start of heading	81	83	288	288	695	21/3	66	10	82	-
VI'	start of heading	77	55	164	164	460	25/0	61	14	83	-
VII	start of blooming	48	86	214	-	510	32/0	63	5	82	-
VIII	start of blooming	47	79	258	-	420	36/0	62	2	80	3.4
VIII'	start of blooming	48	85	240	-	360	37/0	56	7	80	-

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BIOLOGICAL OBSERVATIONS AND MEASUREMENTS

Mission II

Date 19-25 07. 76

Field No.	Stage of vegetation	Height of plants(cm)	Protect. cover(%)	No. of stalks/ m^2	No of ears/ m^2	Weight of dry bio-mass,g/m^2	Weight of dry biomass,%			Moisture of plants,%	Leaf index
							fallen leaves	stems	gener. organs		
1.	milky-yellow ripeness	131	59	165	165	1235	3/7	46	44	61	0.8
2.	milky-yellow ripeness	114	66	341	341	1647	2/8	46	44	67	0.9
3.	10-11 leaves	66	49	7	7	300	66/0	34	-	92	0.1
4.	10-11 leaves	73	29	4	4	100	54/0	46	-	90	0.1
5.	milky-yellow ripeness	128	56	210	210	1010	5/3	59	33	68	1.1
6.	milky-yellow ripeness	129	61	-	-	929	4/4	58	34	63	1.0
7.	active growth	38	6 5	220	-	300	23/25	41	11	75	1.4
8.	start of vegetation	20	60	160	-	100	41/24	35	-	80	1.1
10.	pasture steppe	60	50	112	-	196	45/24	24	7	59	1.6
12.	unmowable steppe	106	83	272	-	416	52/15	29	4	66	3.0
14.	mowable steppe	91	63	212	-	300	48/17	27	8	65	-

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BIOLOGICAL MEASUREMENTS AND OBSERVATIONS

Mission III — Date 18-19 08. 76

Field No.	Stage of vegetation	Height of plants(cm)	Protect. cover,%	No.of stalks/m^2	No. of ears/m^2	Weight of dry bio-mass,g/m^2	Weight of dry biomass,%			Moisture of plants %	Leaf index
							fallen leaves	stems	gener. organs		
1.	complete ripeness	98	88	394	394	2014	0/6	51	43	22	0.2
2.	complete ripeness	135	95	431	431	-	-	-	-	24	-
3.	start of grain ripening	173	59	6	6	1300	-	-	-	87	-
4.	start of grain ripening	149	53	6	6	1540	51/0	49	-	89	-
5.	yellow ripeness	79	79	447	447	1026	0/3	46	51	45	0.8
6.	yellow ripeness	90	58	516	516	1105	0/5	40	55	43	1.5
7.	start of blooming	53	77	-	-	412	-	-	-	65	-
8.	start of blooming	51	81	-	-	250	30/6	58	6	75	-
	Mission IV								Date 22-23 09. 76		
8.	sprouts of winter wheat	10	10	443	-	14	-	-	-	75	-

OBSERVATIONS OF CONDITION OF SOWINGS

Mission I

Date 22-24.06.76

Field No.	Presence and degree of damage					Overall quality	Uniformity	Nature of treatment
	drying	lodging	disease	insect damage	other			
I.	-	strong	-	-	slight weediness	good	uniform sowing	-
II.	slight	slight in places	-	-	no weeds	excellent	uniform sowing	-
III.	-	-	-	-	medium weediness	medium	nonuniform sowing	-
IV.	-	-	-	-	medium weediness	medium	uniform sowing	-
V.	-	very slight	-	-	almost no weeds	excellent	uniform sowing	-
VI.	-	-	-	-	much winter cress	medium	nonuniform sowing	-
VI.'	-	-	-	-	almost no weeds	good	uniform sowing	-
VII.	-	-	-	-	center of field has winter cress	good	nonuniform sowing	-
VIII.	-	-	-	-	medium weediness	good	uniform sowing	-
VIII.	-	-	-	-	medium weediness	good	uniform sowing	-

OBSERVATIONS OF CONDITION OF SOWINGS

Mission II

Date 22-23.07.76

Field No.	Presence and degree of damage					Overall quality	Uniformity	Nature of treatment
	drying	lodging	disease	insect damage	other			
1.	-	stronger in west	-	-	clean sowing	good	uniform sowing	-
II.	-	slight in places	-	-	clean sowing	excellent	uniform sowing	-
III.	-	-	-	-	strong weediness in rows	poor	very nonuniform, biomasses in south	-
IV.	-	-	-	-	medium weediness in rows	good	nonuniform sowing	-
V.	-	present on western field edges	-	-	slight weediness	good	uniform sowing	-
VI.	-	slight	-	-	slight weediness	good	uniform sowing	-
VI'.	-	-	-	-	slight weediness	good	uniform sowing	-
VII.	-	-	-	-	medium weediness	medium	nonuniform(unmowed in eastern part)	clover grows up after mowing
VIII.	-	-	-	-	-	-	clover mowed, field plowed up	from 21.07 harrowing in progress
VIII.'	-	-	-	-	clean sowing	good	uniform sowing	clover grows up after mowing

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OBSERVATIONS OF CONDITION OF SOWINGS

Mission III

Date 18.08.76

Field No.	Presence and degree of damage					Overall quality	Uniformity	Nature of treatment
	drying	lodging	disease	insect damage	other			
I.	-	strong	-	-	clean sowing	good	uniform sowing	-
II.	-	lodging somewhere	-	-	very weak weediness	excellent	uniform sowing	-
III.	-	-	-	-	strong weediness	poor	nonuniform sowing	-
IV.	-	-	-	-	strong weediness	medium	uniform sowing	-
V.	-	noticeable lodging	-	-	slight weediness	good	uniform sowing	-
VI.	-	medium	-	-	weeds especially in west	medium	uniform sowing	-
VI'.	-	lodging in places	-	-	clean sowing	good	uniform sowing	-
VII.	-	-	-	-	slight sowing	good	uniform sowing	swaths lying in eastern part
VIII.	-	-	-	-	-	-	second harrowing in progress for field under sowing of winter wheat	
VIII.'	-	-	-	-	-	-	-	-

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

OBSERVATIONS OF CONDITION OF SOWINGS

Mission IV

Date 20-23.09.76

Field No.	Presence and degree of damage					Overall quality	Uniformity	Nature of treatment
	drying	lodging	disease	insect damage	other			
1.	-	-	-	-	-	-	fall-plowed field medium- and coarse lumpy (dry surface)	
II.	-	-	-	-	-	-	the same	
III.	-	-	-	-	-	-	corn stubble	
IV.	-	-	-	-	-	-	corn stubble	
V.	-	-	-	-	-	-	spring wheat stubble	
VI.	-	-	-	-	-	-	clover beginning to grow up on spring wheat stubble	
VI'.	-	-	-	-	-	-	-	-
VII.	-	-	-	-	many weeds	medium	nonuniform in eastern part, minimum biomass	-
VIII.	-	-	-	-	clean sowing	good	uniform sowing	-
VIII.	-	-	-	-	-	-	-	-

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OBSERVATIONS OF CONDITIONS OF SOWINGS

Mission VIa

Date 9.9.76

Field No.	Presence and degree of damage					Overall quality	Uniformity	Nature of treatment
	drying	lodging	disease	damage	other			
I.	-	-	-	-	-	-	-	winter wheat harvested
II.	-	-	-	-	-	-	-	winter wheat harvested
III.	-	-	-	-	medium weediness	good	nonuniform sowing	-
IV.	-	-	-	-	slight weediness	good	nonuniform sowing	-
V.	-	medium	-	-	medium weediness	good	nonuniform sowing	-
VI.	-	-	-	-	-	-	-	-
VI.'	-	-	-	-	-	-	-	spring wheat harvested
VII.	-	-	-	-	medium weediness	medium	nonuniform sowing due to weediness	in eastern part biomass lower due to weediness
VIII.	-	-	-	-	-	-	-	sowing of winter wheat
VIII*.	-	-	-	-	slight weediness	medium	nonuniform sowing	spots of open soil visible
fallow land	-	-	-	-	stubble remnants	-	uneven moisture of soil surface	medium-lumpy plowed field

VIII*.--clover spectrometered on southern slope of Tolstiy ravine (southern Zapovednik--preserve)

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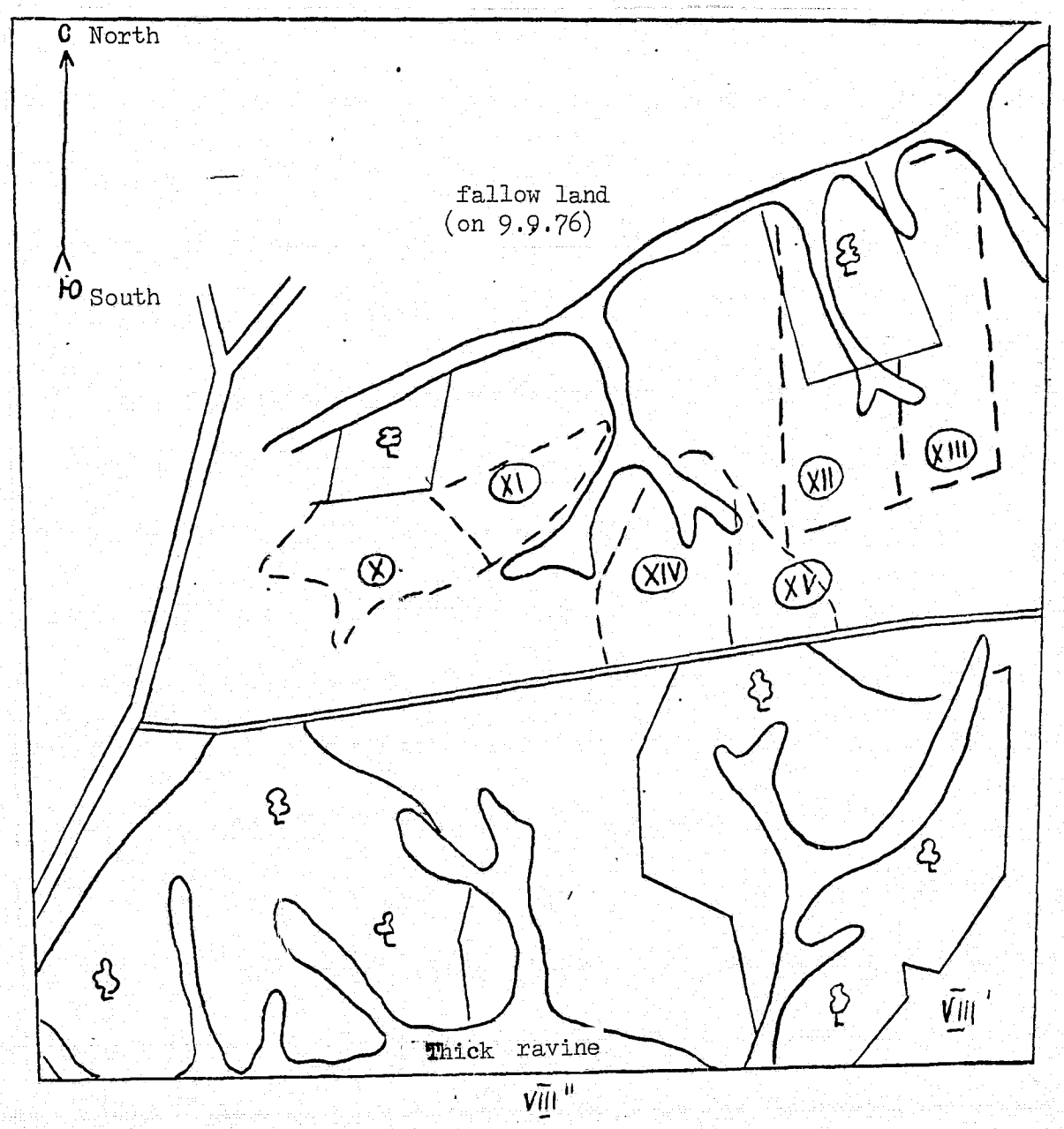


Scale 1:30,000

0 300 1500 м

X, XI - Plowable steppe

XII, XIII - Unmowable steppe

XIV, XV - Mowable steppe

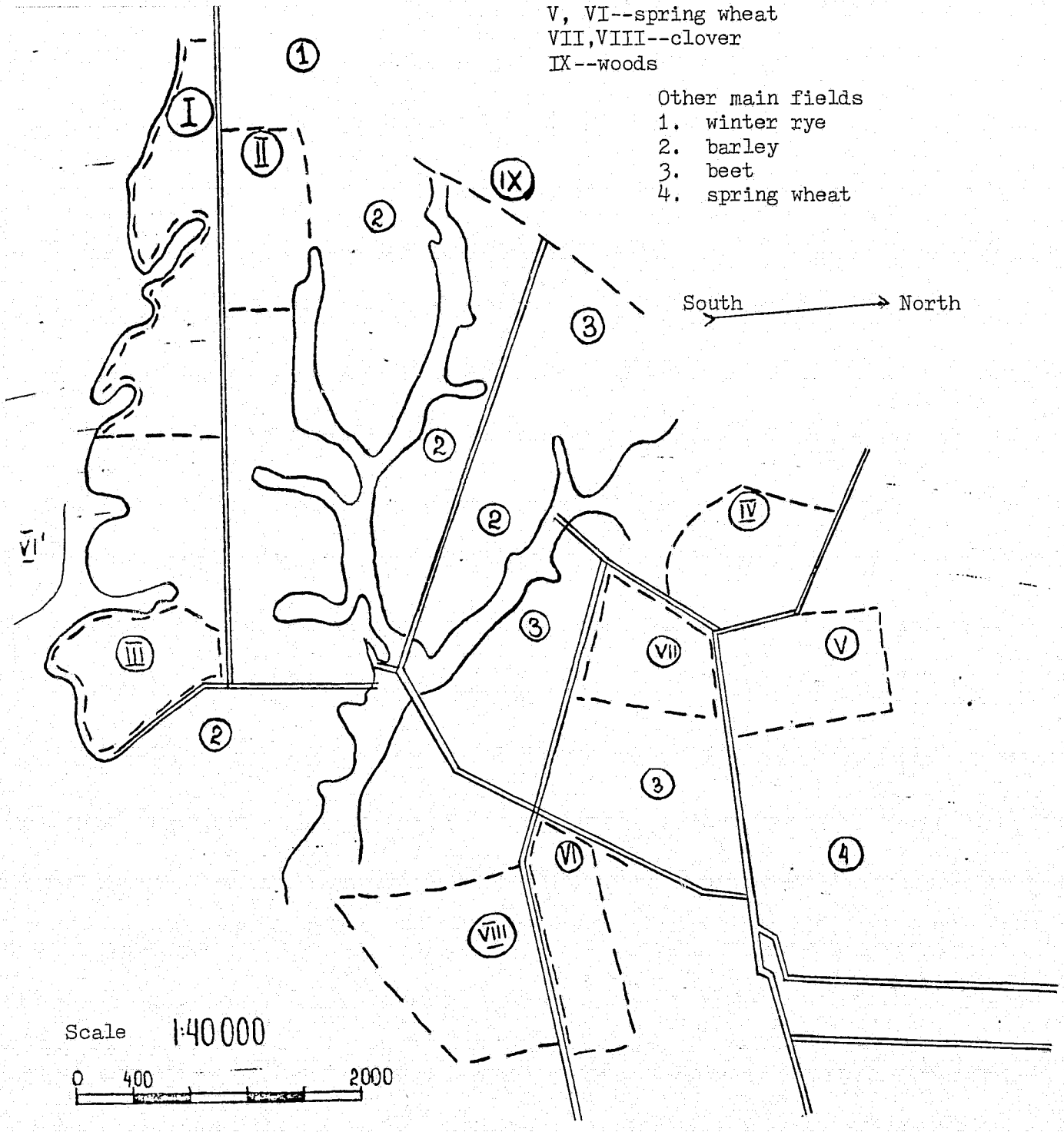
Schematic Drawing of Test Section "Zapovednik" (Preserve)

Fields included in observation program

I,II--winter wheat
III-IV, corn
V, VI--spring wheat
VII,VIII--clover
IX--woods

Other main fields

1. winter rye
2. barley
3. beet
4. spring wheat



Schematic Diagram of Test Fields

Appendix 4 /105

Ground Photographs of Fields

CATALOGUE OF GROUND PHOTOGRAPHS /106

Date	No. in order	Height of camera	f lens	Subject of photography	Direction of photography
1	2	3	4	5	6
5.05.76	1	motor	20 mm	corn	oblique
	2	vehicle		"	
	3	h≈3 m		clover	
	4			"	
	5			corn	
	6			"	
	7			clover	
	8			"	
	9			spring wheat	
	10			"	
	11			"	
	12			"	
	13			" another	
	14			" field	
	15			steppe	
	16			"	
	17			winter wheat	
	18			"	
	19			" sun behind	
	20			" clouds	
31.5.76	1	tower	20 mm	winter wheat	All photographs oblique
	2	wagon		"	
	3	h=23 m		corn	
	4			"	
	5			clover	
	6			"	
	7			spring wheat	
	8			"	
26.6.76	1	motor	20 mm	winter wheat	Close to planned
	2	vehicle		"	Oblique with different
	3	h≈3-		"	direction of photog.
	4	3.5 m		corn	Close to planned
	5			corn	Oblique with different
	6				direct.of photog.
	7			clover	Close to planned /107
	8			"	Oblique with diff.
	9				direct. of photog.
	10			spring wheat	Close to planned
	11			spring wheat	Oblique with diff.
					direct. of photog.

(continued from previous page)

	13			steppe,mowable	Oblique with different
	14			unmowed	direction of photography
	15			"	
	16	h=2 m	20 mm	"	Oblique with different
	17				direction of photography
22.7.76	1	motor	20 mm	winter wheat	Close to planned
	2	vehicle		"	Oblique with different
	3	h=3-			direction of photography
	4	3.5 m		"	The same as No. 3 with underexposure (defective)
	5			clover	Close to planned
	6			"	Oblique
	7			corn	Close to planned
	8			"	Oblique
	9			spring wheat	Close to planned
	10			"	Oblique
	11	h=2 m		steppe, mowable	Oblique with different
				unmowed	direction and angles of
	12			"	photography
	13			"	

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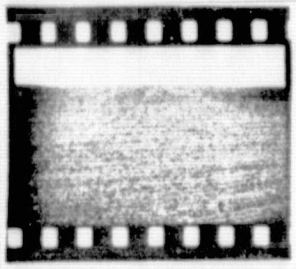
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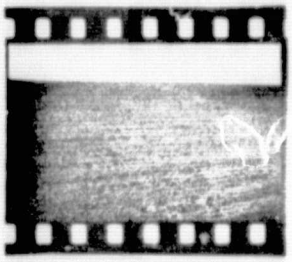
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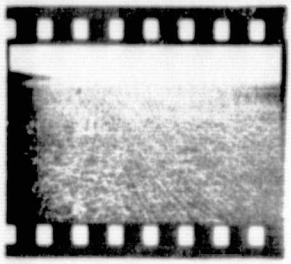
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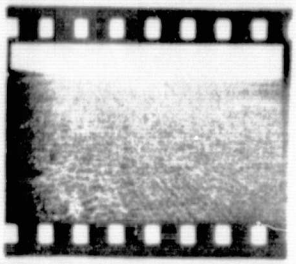
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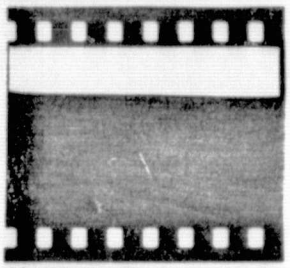
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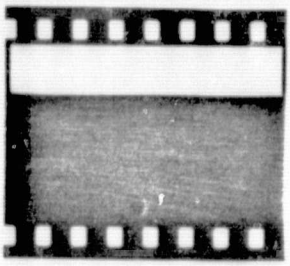
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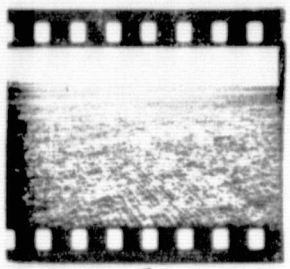
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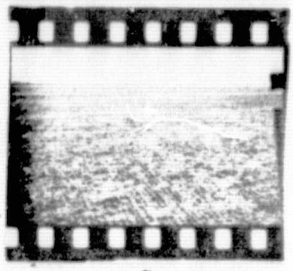
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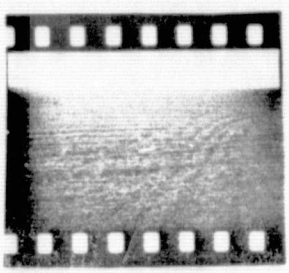
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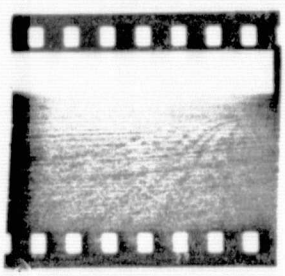
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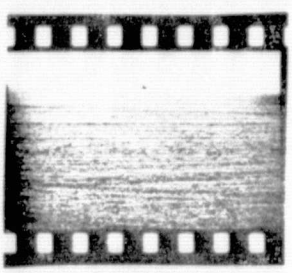
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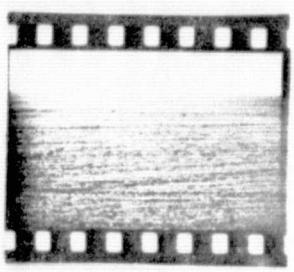
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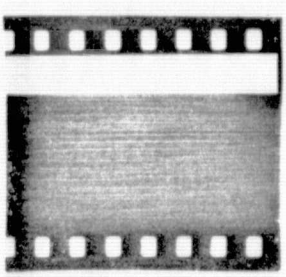
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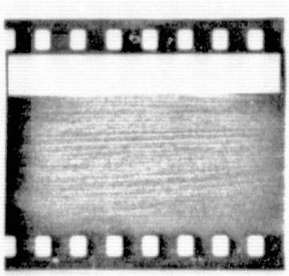
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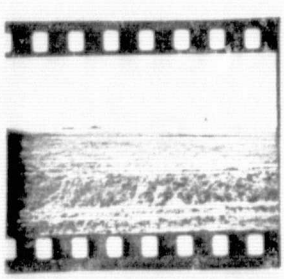
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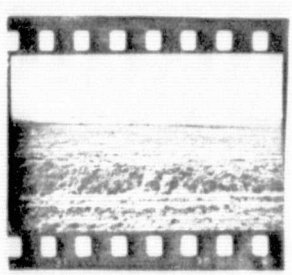
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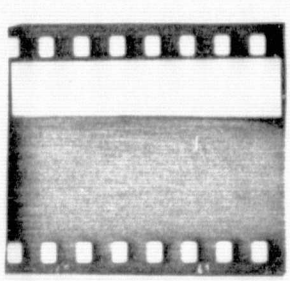
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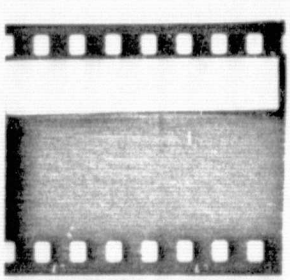
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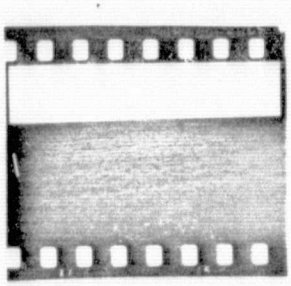
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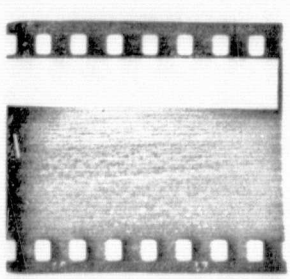
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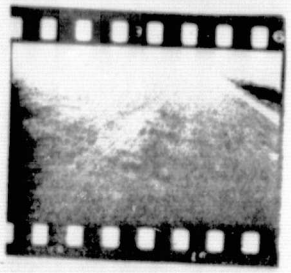
31 May 1976



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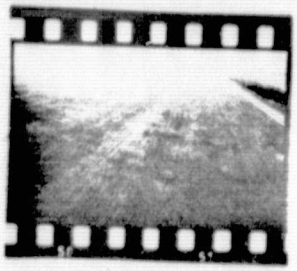

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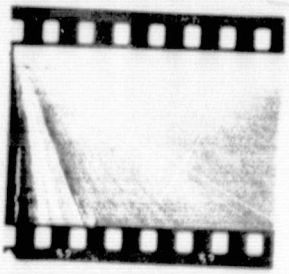

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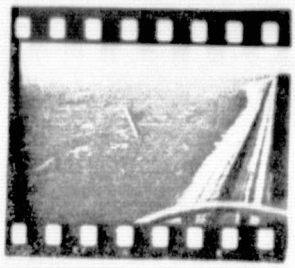

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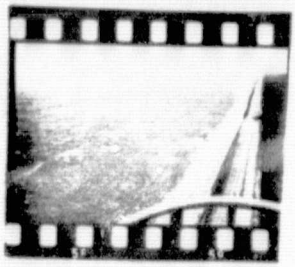

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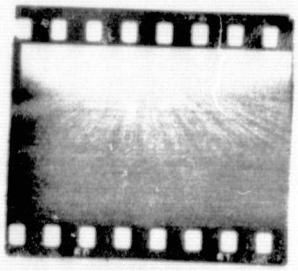

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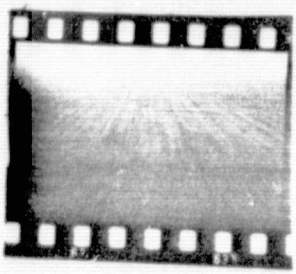

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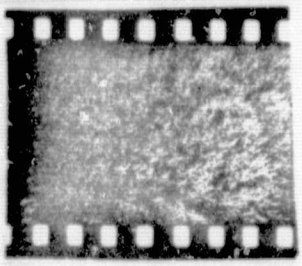

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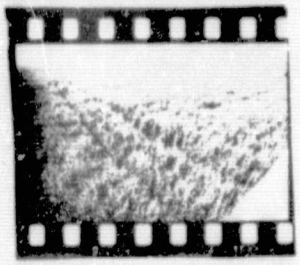

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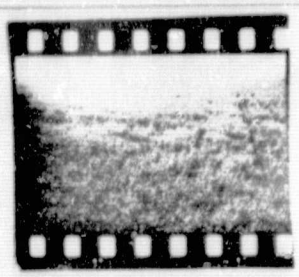

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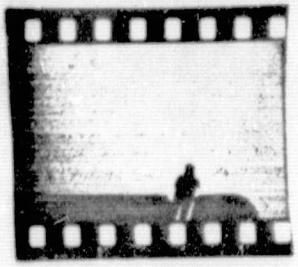

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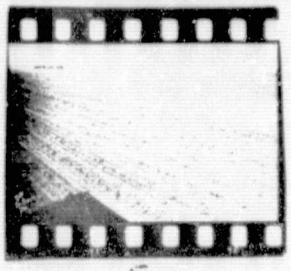

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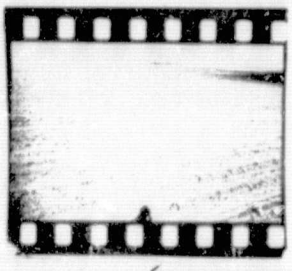

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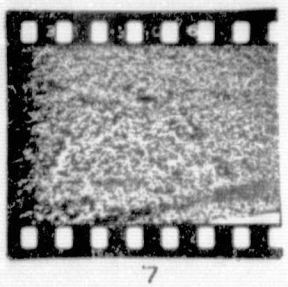

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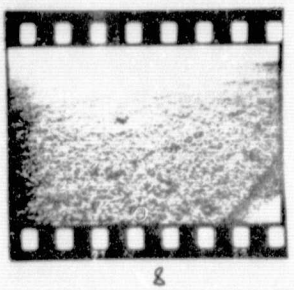

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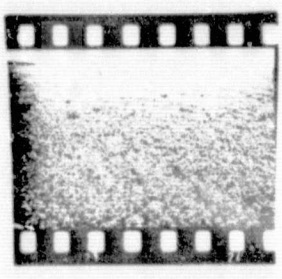

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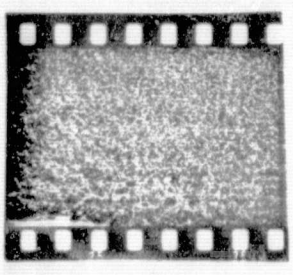

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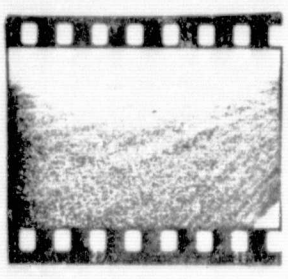

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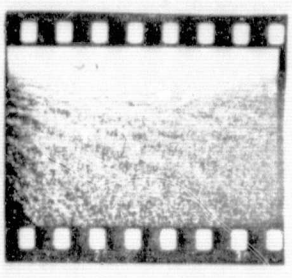

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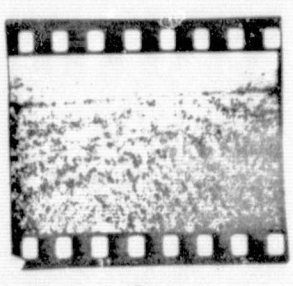

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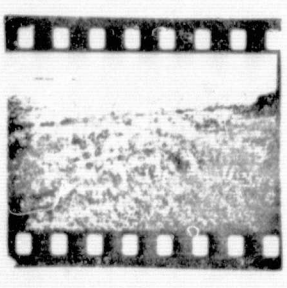

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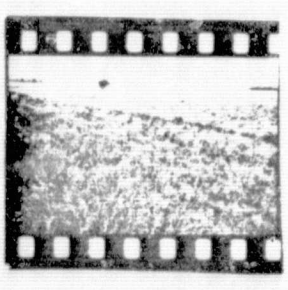

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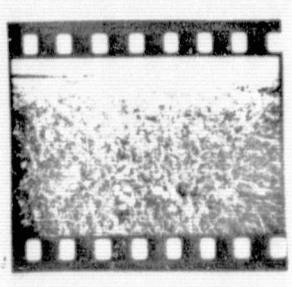

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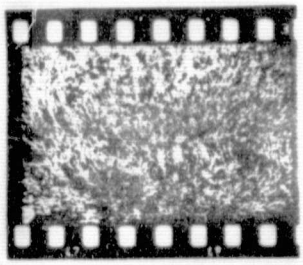

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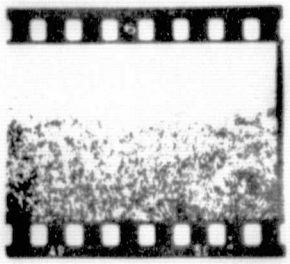

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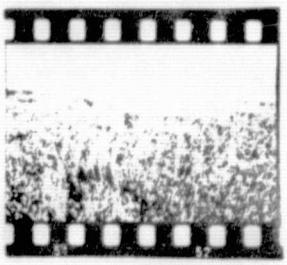

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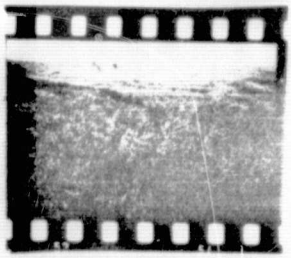

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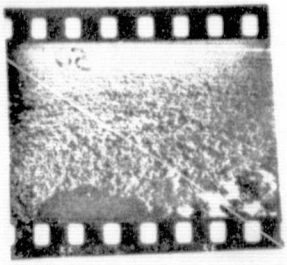

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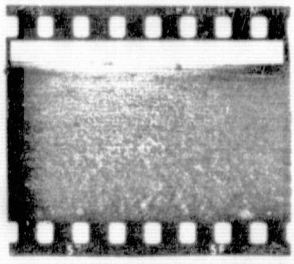

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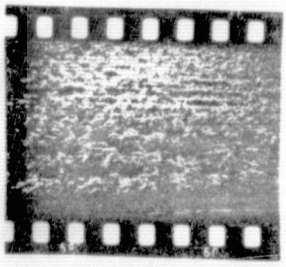

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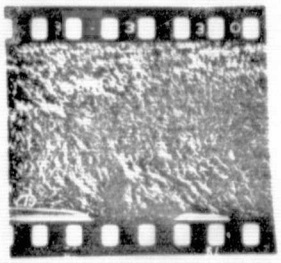

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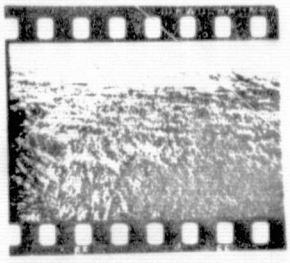

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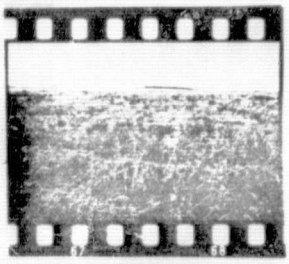

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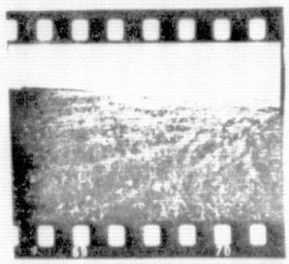

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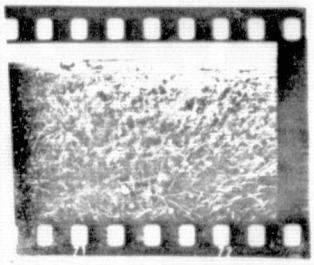

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Appendix 5 /108

Sampling Mean and Standard Deviations of Optic Densities of Images.

6.10.75 /109

zones / targets	0.44-0.48 µm	0.52-0.59 µm	0.67-0.73 µm	0.72-0.86 µm
winter wheat	0.898 0.020	0.625 0.020	0.885 0.029	I.39I 0.06I
clover	0.856 0.0I0	0.752 0.0I7	I.I20 0.047	I.347 0.024
oak	0.752 0.063	0.72I 0.079	I.026 0.030	I.2I3 0.066
plowing	0.827 0.0I2	0.8I4 0.024	I.I32 0.0II	I.059 0.052

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24.VI.76

zones / targets	0.4-0.5 μm	0.5-0.6 μm	0.6-0.7 μm	0.7-0.76 μm
I--winter wheat	I.25I 0.043	I.049 0.028	0.934 0.098	I.638 0.052
II--winter wheat	I.I43 0.02I	I.I30 0.03I	0.876 0.042	I.538 0.024
IV--corn	I.3I3 0.0I3	Io202 0.023	I.38I 0.03I	0.7I9 0.027
V--spring wheat	I.247 0.0I2	I.I47 0.026	0.86I 0.044	I.59I 0.043
VII--clover	I.270 0.0I3	I.I90 0.023	0.998 0.09I	I.732 0.029
VIII--clover	I.I39 0.0I2	0.92I 0.065	0.8I2 0.042	I.564 0.044
IX--oak woods	I.I74 0.034	I.04I 0.098	0.808 0.I32	I.33I 0.II4
X--pasture steppe	I.0I4 0.0I4	I.096 0.032	0.907 0.047	I.205 0.026
XI--pasture steppe	0.948 0.026	I.0I5 0.02I	0.944 0.033	I.228 0.026
XII--unmowable steppe	0.887 0.040	0.976 0.036	0.79I 0.073	I.394 0.04I
XIII--unmowable steppe	0.722 0.02I	0.859 0.049	0.763 0.044	I.237 0.027
XIV--mowable steppe	I.I03 0.0I5	I.046 0.024	0.94I 0.036	I.424 0.04I
XV--mowable steppe	0.840 0.0I5	0.998 0.059	0.829 0.032	I.220 0.038

zones / targets	0.4-0.5 μm	0.5-0.6 μm	0.6-0.7 μm	0.7-0.76 μm
I--winter wheat	1.056 0.022	0.912 0.050	0.792 0.075	0.905 0.071
II--winter wheat	1.011 0.032	0.774 0.054	0.637 0.046	0.746 0.117
III--corn	1.036 0.021	0.833 0.018	0.500 0.053	0.995 0.077
IV--corn	0.976 0.016	0.545 0.060	0.422 0.043	0.299 0.054
V--spring wheat	0.816 0.022	0.503 0.036	0.384 0.032	0.462 0.064
VI--spring wheat	0.904 0.024	0.622 0.026	0.621 0.059	0.400 0.033
VII--clover	0.953 0.018	0.694 0.021	0.539 0.054	0.813 0.110
VIII--clover	0.913 0.036	0.605 0.023	0.548 0.019	0.301 0.149
IX--oak woods	0.774 0.026	0.341 0.057	0.183 0.048	0.292 0.102
X--pasture steppe	0.946 0.013	0.626 0.024	0.473 0.032	0.485 0.057
XI--pasture steppe	0.924 0.015	0.602 0.020	0.502 0.025	0.443 0.030
XII--unmowable steppe	0.911 0.014	0.400 0.026	0.347 0.024	0.622 0.050
XIII--unmowable steppe	0.976 0.016	0.441 0.021	0.309 0.024	0.606 0.046
XIV--mowable steppe	0.905 0.026	0.636 0.045	0.570 0.046	0.226 0.022
XV--mowable steppe	0.892 0.020	0.527 0.026	0.555 0.035	0.227 0.021

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zones / targets	0.4-0.5 μm	0.6-0.7 μm	0.7-0.76 μm
I--winter wheat	I.375 0.032	I.506 0.060	0.589 0.05I
II--winter wheat	I.28I 0.059	I.420 0.085	0.472 0.080
III--corn	I.346 0.052	I.253 0.020	0.250 0.0I6
IV--corn	I.I50 0.0I6	I.022 0.02I	0.I73 0.0I8
V--spring wheat	I.II8 0.029	I.206 0.023	0.357 0.035
VI--spring wheat	I.306 0.0I8	I.3I2 0.024	0.3I9 0.020
VII--clover	I.I74 0.0I5	I.II0 0.0I4	0.I62 0.0I6
VIII--clover	I.308 0.0I2	I.I33 0.0I4	0.I94 0.0I6
IX--oak woods	I.I94 0.023	I.040 0.095	0.I3I 0.032
X--pasture steppe	I.22I 0.030	I.I30 0.027	0.292 0.0I3
XI--pasture steppe	I.208 0.0I6	I.2I8 0.029	0.3I8 0.022
XII--unmowable steppe	I.230 0.0I0	I.I5I 0.038	0.252 0.027
XIII--unmowable steppe	I.233 0.0I7	I.I53 0.024	0.235 0.020
XIV--mowable steppe	I.263 0.0I9	I.223 0.025	0.304 0.036
XV--mowable steppe	0.75I 0.020	I.I96 0.020	0.260 0.0I5

zones / targets	0/4-0.5 um	0.5-0.6 um	0.6-0.7 um	0.7-0.76 um
I--winter wheat	0.389 0.040	0.037 0.009	0.II3 0.029	0.275 0.044
II--winter wheat	0.320 0.0I4	0.030 0.009	0.064 0.0I4	0.2I9 0.029
IV--corn	0.359 0.026	0.07I 0.0I0	0.I73 0.025	0.730 0.036
V--spring wheat	0.234 0.033	0.037 0.0I0	0.339 0.097	0.900 0.I04
VII--clover	0.232 0.02I	0.052 0.0I2	0.036 0.0I0	I.I53 0.I3I
VIII--clover	-	-	0.003 0.0I5	0.793 0.056
IX--oak woods	0.349 0.028	0.032 0.0II	0.057 0.0I3	0.653 0.2I6
X--pasture steppe	0.4I8 0.0I5	0.I50 0.0I0	0.3I3 0.028	I.359 0.046
XI--pasture steppe	0.429 0.02I	0.I4I 0.0I8	0.344 0.027	I.324 0.034
XII--unmowable steppe	0.553 0.023	0.03I 0.0I0	0.I94 0.0I8	I.352 0.052
XIII--unmowable steppe	0.493 0.0I5	-	0.I6I 0.0I4	I.253 0.054
XIV--mowable steppe	0.409 0.0II	0.I58 0.0I0	0.253 0.040	I.474 0.064
XV--mowable steppe	0.26I 0.022	0.060 0.009	0.I53 0.0I3	I.420 0.035

Appendix 6. Tables of Entropy Values

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ENTROPY OF EXPERIMENTAL RECOGNITION OF TARGETS BY OPTIC DENSITIES OF ZONAL AERIAL PHOTOGRAPHS

Date	zones (μm) \ targets	winter wheat	corn	spring wheat	clover	woods	plowing	Entire group of targets
[illegible].10.75	0,44-0,48	0,174			0,057	0,[illegible]09	0,072	0,280
	0,52-0,59	0,131			0,121	0,[illegible]95	0,090	0,361
	0,67-0,73	0,009			0,159	0,[illegible]84	0,098	0,179
	0,72-0,80	0,351			0,208	0,209	0,057	0,466
24.09.76	0,40-0,50	0,210	0,045	0,104	0,127	0,241		0,309
	0,50-0,60	0,078	0,228	0,554	0,214	0,161		1,054
	0,60-0,70	0,[illegible]84		0,541	0,[illegible]00	0,305		0,857
	0,70-0,76	0,[illegible]09		0,411	0,018	0,050		0,456
10.09.76	0,40-0,50	0,[illegible]07	0,[illegible]15	0,[illegible]36	0,[illegible]00	0,220		0,010
	0,60-0,70	0,046	0,080	0,074	0,048	0,164		0,313
	0,70-0,76	0,[illegible]14	0,127	0,[illegible]94	0,147	0,151		0,[illegible]68
20.09.76	0,40-0,50	0,405	0,[illegible]04	0,009	0,[illegible]60	0,[illegible]04		0,021
	0,50-0,60	0,[illegible]90	0,[illegible]15	0,[illegible]93	0,[illegible]23	0,254		0,[illegible]07
	0,60-0,70	0,[illegible]03	0,079	0,[illegible]06	0,139	0,[illegible]39		0,452
	0,70-0,76	0,[illegible]02	0,139	0,[illegible]49	0,[illegible]27	0,[illegible]25		0,[illegible]30
22.07.76	0,[illegible]-0,[illegible]	0,[illegible]38	0,[illegible]27	0,[illegible]38	0,[illegible]11	0,[illegible]38		0,[illegible]31
	0,[illegible]-0,[illegible]	0,[illegible]11	0,[illegible]07	0,[illegible]10	0,[illegible]45	0,[illegible]06		0,[illegible]07
	0,[illegible]-0,[illegible]	0,[illegible]33	0,[illegible]01	0,[illegible]36	0,[illegible]31	0,[illegible]20		0,[illegible]
	0,[illegible]-1,[illegible]	0,[illegible]11	0,[illegible]05	0,[illegible]03	0,[illegible]27	1,[illegible]00		0,[illegible]

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ENTROPY OF EXPERIMENTAL RECOGNITION OF TARGETS /116

BY CSI 22.VI.76

targets / zones (μm)	winter wheat	corn	spring wheat	clover	woods	Entire group of targets
0,40-0,42	0,5I7	0,0I9	0,456	0,I9I	0,I08	0,759
0,43-0,45	0,88I	0,298	0,806	0,270	0,024	I,38I
0,48-0,5I	0,777	0,040	0,54I	0,280	0,I07	0,9I4
0,52-0,5	0,780	0,I29	0,456	0,296	0,280	I,089
0,55-0,57	0,800	0,402	0,272	0,200	0,30I	I,I78
0,57-0,59	0,900	0,502	0,896	0,25I	0,I89	I,200
0,62-0,64	0,78I	0,0I5	0,506	0,200	0,I96	0,904
0,65-0,67	0,879	0,0	0,282	0,239	0,248	0,787
0,67-0,69	0,722	0	0,528	0,284	0,092	0,385
0,72-0,74	0,874	0	0,498	0,286	0,3I0	0,98I
0,75-0,77	0,898	0	0,474	0,274	0,875	I,048
0,85-0,88	0,447	0	0,98I	0,29I	0,2	0,778
0,90-0,92	0,476	0	0,295	0,248	0,807	0,758
0,97-0,99	0,822	0	0,459	0,98I	0,3I8	I,007
I,0I-I,08	0,779	0	0,545	0,288	0,387	I,002

[Translator's note: All commas in numerals represent decimal points.]

ENTROPY OF EXPERIMENTAL RECOGNITION OF TARGETS

BY CSI 23.VII.76

targets / zones (μm)	winter wheat	corn	spring wheat	clover	woods	Entire group of targets
0,40-0,43	0,804	0,840	0,814	0,I28	0,I88	0,[illegible]
0,43-0,45	0,5I0	0,407	0,[illegible]	0,080	0,I4I	0,[illegible]I2
0,49-0,5I	0,20I	0,I44	0,I77	0,254	0,II7	0,[illegible]
0,52-0,54	0,059	0,028	0,I82	0,I8I	0,208	0,4I5
0,55-0,57	0,I03	0,28I	0,I47	0,209	0,I84	0,5I2
0,57-0,59	0,005	0,I50	0,020	0,077	0,I74	0,228
0,62-0,64	0,I28	0,I98	0,075	0,I75	0,II5	0,875
0,65-0,67	0,4I8	0,420	0,I87	0,2I5	0,I45	0,707
0,67-0,69	0,24I	0,284	0,00I	0,I55	0,I28	0,4I4
0,72-0,74	0,44I	0,2I0	0,838	0,289	0,004	0,894
0,75-0,77	0,888	0,I5I	0,594	0,I80	0,008	0,807
0,80-0,82	0,598	0,029	0,275	0,466		0,708
0,90-0,92	0,885	0,029	0,47I	0,294	0,092	0,8I2
0,97-0,99	0,888	0,097	0,092	0,I08	0,I50	0,954
I,0I-I,08	0,480	0,I09	0,888	0,294	0,I95	0,7I8

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ENTROPY OF EXPERIMENTAL RECOGNITION OF TARGETS

BY CSI 9.IX.76

targets / zones (um)	fallow land	corn	spring wheat	clover	woods	Entire group of targets
0,40-0,42	0,098	0,2I0	0,222	0,I85	0,I9I	0,488
0,48-0,45	0,095	0,24I	0,255	0,I42	0,I88	0,525
0,49-0,5I	0,544	0,I93	0,528	0,I29	0,202	0,682
0,52-0,54	0,097	0,490	0,402	0,240	0,I80	I,I47
0,55-0,57	0,478	0,4I7	0,04I	0,082	0,I72	0,327
0,57-0,59	0,209	0,I77	0,III	0,08I	0,I9I	0,4I7
0,62-0,64	0,I75	0,20I	0,I73	0,II5	0,I80	0,480
0,65-0,67	0,200	0,I84	0,203	0,I80	0,II0	0,439
0,67-0,69	0,I82	0,I87	0,I82	0,II4	0,III	0,850
0,72-0,74	0	0,I95	0,I72	0,092	0,2I8	0,889
0,75-0,77	0	0,I82	0,0I0	0,I20	0,008	0,I80
0,80-0,82	0	0,090	0,0I0	0,II4	0,050	0,I80
0,90-0,92	0	0,I47	0,022	0,I48	0,027	0,I78
0,97-0,99	0	0,I02	0,035	0,I57	0,078	0,280

```
C     PROGRAM  GRET
1     DIMENSION FX(301),A(13),D(13),P(13),F(13),B(13),H(13),A1(13),A2(13
2    1),H1(13),C1(13),HOP2(13),HOP3(13)
3     DATA N21/4/,E/0.01/
4     READ (1,50)(FX(K),K=1,301)
5  50 FORMAT (13F6.4)
      DO 32 I21=1,N21
6     READ (1,52)(A(I),I=1,13)
7     READ (1,52)(D(I),I=1,13)
8     READ (1,52)(P(I),I=1,13)
9     READ (1,54)T1,T2
10 52 FORMAT (13F6.3)
11 53 FORMAT (13F6.2)
12 54 FORMAT (2F6.2)
13    DO 33 I22=1,13
14    IF(A(13))36,35,36
15 36 N=13
16    GO TO 37
17 35 IF(A(I22))33,34,33
18 34 N=I22-1
19    GO TO 37
20 33 CONTINUE
21 37 DO 1 I=1,N
22    H1(I)=0
23    A1(I)=A(I)-3*D(I)
24  1 A2(I)=A(I)+3*D(I)
25    XMIN=A1(1)
26    XMAX=A2(1)
27    DO 42 I=2,N
28    IF(XMAX-A2(I))2,3,3
29  2 XMAX=A2(I)
30  3 IF(XMIN-A1(I))42,42,4
31  4 XMIN=A1(I)
32 42 CONTINUE
```

Commentary on program.

Input information:

A(I)--mean value of CSI or D of -target
D(I)--standard deviation.
P(I)--a priori probability of appearance of - target
E --step of sign change

2I--number of simultaneously solvable problems
FX(K)--probability of entry of normed normal quantity into interval 0,X (Laplace function)
K=100X + I, where X--independent variable of Laplace function.

Output information:

H--initial entropy.

HI--entropy of experiment.

I--quantity of information.

```
      M=(XMAX-XMIN)/E
      HO=0
      HOP=0
      DO 21 J=1,M
      I=0
      C=0
      DO 6 I=1,N
      X5=100*(XMIN-A(I))/D(I)
      K=ABS(X5)+1.5
      IF(K-301)8,8,7
    7 K=301
    8 F1=SIGN(FX(K),X5)
      X4=100*(XMIN-A(I)+E)/D(I)
      K=ABS(X4)+1.5
      IF(K-301)9,9,10
   10 K=301
    9 F2=SIGN(FX(K),X4)
      F(I)=ABS(F1-F2)
      T=T+P(I)*F(I)
    6 CONTINUE
      IF(T)40,40,39
   39 DO 38 I=1,N
      B(I)=P(I)*F(I)/T
      IF(B(I))38,38,41
   41 H(I)=B(I)*ALOG10(B(I))/0.301
      C=C-H(I)
   55 IF(B(I)-1.)44,38,44
   44 C1(I)=(-B(I)*ALOG10(B(I))-(1.-B(I))*ALOG10(1.-B(I)))/0.301
      H1(I)=H1(I)+C1(I)*T
   38 CONTINUE
      HO=HO+T*C
   40 XMIN=XMIN+E
   21 CONTINUE
```

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```
      DO 22 J=1,N
      HOP2(J)=(-P(J)*ALOG10P(J))-(1.-P(J))*ALOG10(1.-P(J)))/0.301
      HOP3(J)=HOP2(J)-H1(J)
   22 HOP=HOP-P(J)*ALOG10(P(J))/0.301
      HOP1=HOP-HO
      IF(I21-1)47,47,48
   47 WRITE (3,23)
   23 FORMAT(10X, COMPUTATION OF QUANTITY OF INFORMATION FOR RECOGNITION OF TARGETS
     *B!/10X,75('-')/10X,' ZONE ',4X,' TARGETS ',4X,'P',7X,'A',7X,'
     *D',7X,'H',7X,'H1',7X,'I'/10X,75('-'))
   48 WRITE (3,24) T1,T2,HOP,HO,HOP1
   24 FORMAT(10X,F4.2,'-',F4.2,5X,'ENTIRE GROUP ',23X,3F8.3)
      DO 32 I=1,N
      WRITE(3,25)I,P(I),A(I),D(I),HOP2(I),H1(I),HOP3(I)
   25 FORMAT (25X,I4,F13.3,5F8.3)
   32 CONTINUE
      STOP
      END
```

Appendix 7. /120

Technique of Biological Measurements

Technique of Biological Measurements on Experimental Sections of Soviet-American Program /121

1. Stage of growth (phases of vegetation, aspects) see appendix.

2. Height of plants. 5 randomly selected plants on area are measured with a graduated rule with natural position of leaves. Data are averaged and recorded on the form.

3. Percentage of cover. Determined in the field visually by method of expert evaluation (average of evaluations given by three individuals).

4. Number of plants per unit of area. For wheat in 1976 the number of plants were computed per 1.5 m of rows (individual plants were counted by pulling them out with the roots), in 1977 the calculations will be made on 1 m of rows. Clover is counted without pulling the plants out. Corn plants are counted per 10 m of rows. Data for the number of plants in rows are recounted for 1 m^2 with regard to the distance between rows. Individual specimens were not counted for natural vegetation.

5. Leaf index. In dry crops on each area five green and five yellowed leaves are selected from the section of leaf cover of the crop which was the average in height. A sample of definite size (0.5-5 cm^2) is cut from each leaf. The samples are dried and the absolute dry weight of a unit of leaf area is determined (specific surface density, SSD). By division of the weight of leaves from 1 m^2 area of sowing (for determination of biomass see further) by the SSD the area is computed for green and yellow leaves per 1 m^2 of sowing.

For natural vegetation the approximate value of SSD of the community is determined as the weighted average SSD for three of the most high-volume types

(statistical weighing occurs according to the protective cover). Thus, if types A,B, and C have in the community cover of 40, 15 and 5%, the average SSD of the community is determined as

$$SSD_{comm} = \frac{40SSD_A + 15SSD_B + 5SSD_C}{60}$$

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6. Biomass. In order to determine biomass the above ground sections of all plants were weighed on the test section of the row or mowing square. Weeds are included in the biomass calculation. Weighing in the dry form occurs directly in the field with the help of a densimeter (snow gage) which is used in meteorology for snow photography. The accuracy of weighing is 5 g. Then the sample is taken apart into fractions: leaves, stems, generative parts, defoliation, which are also weighed. The weights are totaled; in the case of a discrepancy in the weight before and after disassembly as a consequence of a loss in moisture during the disassembly the weights of the fractions are multiplied by the correction coefficient equal to $\frac{g_1}{g_2}$ where g_1--the weight of the cutting before disassembly, g_2--after disassembly.

The disassembled sample is dried in a desiccator and its dry weight is determined by fractions.

After this the moisture content is determined for each fraction of biomass and of the sample as a whole according to the formula

$$W\ (\%) = \left(1 - \frac{g_2}{g_1}\right) \times 100$$

7. Damages. The presence or lack of damages is listed in the form of field measurements. In the notes cases are observed of especially extensive spread of damages.

8. General information (notes). Any peculiarities of the field not planned for by the form are indicated.

9. Photographic material. Photographs of fields and vertical structure of the vegetation are prepared for each field.

Appendix /123

SYSTEM OF PHASES OF VEGETATION OF DIFFERENT PLANT COVERS

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No.	Grains	Clover	Natural steppe vegetation
01	sprouts	opening of leaves	Opening of leaves
02	bushing out	vegetative growth	vegetative growth of dominants, aspect of ephermeroids
03	emergence into tubules	growth of generative sprouts	growth of generative sprouts of dominants, aspect of early-summer species
04	heading	blooming	blooming of dominants, overall maximum number of blossoming species
05	milky ripeness	end of blooming	end of blooming of dominants
06	milky-yellow ripeness	immature fruits	Mass maturing of fruits, blooming of late-summer species
07	yellow ripeness	mature fruits	yellowing of leaves, mass fruit bearing
08	complete ripeness	seeding	vegetation after fruit bearing appearance of fall leaves
09	stubble	aftergrowth	aftergrowth

Appendix 8. /124

Description of Spectrometer

The spectrometer consists of two units. Unit 1, the optic head is installed /125
on a cantilever beyond the limits of the helicopter cabin. Unit 2, the recording section, is located within the helicopter cabin.

The spectrometer is two-channel: one channel is directed vertically down, the second up. The upper channel is standard. The standard used is opal glass brand MS-13. The opal glass is additionally standardized on the ground according to a barytic screen installed underneath the instrument in the field of view of the input lens.

The angle of vision is determined by cap cones and is 11°. The angle of vision of the spectrometer can be changed by installing other cones in the limits from 3° to 20°.

Input and collimator lenses ensure the creation of parallel beams at the site where they pass through the light filters. The focusing lens collects the beams on the photocathode of the emission receiver.

Interference light filters installed on the rotating disk alternately transmit streams which go from the top and from the bottom. Thus, in one turn of the disk 15 light filters transmit to the emission receiver 30 distinct portions of light energy. Accordingly, the emission receiver generates 30 distinct electrical signals.

One turn of the disk is completed in 1/15 sec. The emission receiver is the photoelectronic photomultiplier FEU-22 with oxygen-silver-cesium photocathode.

The interference light filters have the following parameters:

Maximum transmission (nm)	Spectrum resolution (nm)
1--410	10-15
2--438	
3--500	

Maximum transmission (nm)	Spectrum resolution (nm)	Maximum transmission (nm)	Spectrum resolution (nm)
4--530		10--728	10-15
5--560		11--755	
6--582	10-15	12--866	
7--622		13--910	15-20
8--657		14--983	
9--682		15--1020	

The recording unit consists of an amplifier and cathode-ray tube. Thirty /126
signals from the emission receiver are amplified and fed to the cathode-ray tube. Here also is fed a signal from the synchronization transmitter which synchronizes the start of sweep of the ray of the cathode-ray tube at the velocity of disk rotation. As a result on the tube screen an immobile signal illuminates which consists of 30 peaks. These peaks are photographed on film. The photography time is 1/8 sec.

The recording unit also generates a high voltage (1400 V) which is necessary for feeding the emission receiver.

The accuracy of determining the coefficient of spectrum intensity is 10%.

Some general parameters of the instrument are:

1) weight of optic head--8 kg.
2) weight of recording unit--10 kg.
3) dimensions of optic head--diameter--350 mm, height 430 mm
4) dimensions of recorder--170 x 223 x 700 mm
5) feed voltage--24 ± 3 V.
6) power consumed--50 watts.

The photography occurred from an altitude of 100 meters which provided on the earth a resolving area 20 meters in diameter. The velocity of the horizontal flight was 50-60 kph. Thus, during the recording of one spectrogram (1/8 sec.) the center of the spot does not shift by more than 2 m. Photography of the successive frames occurs with an interval of 1 sec. The helicopter usually advances over the field in the opposite direction of the wind.

For the 1977 season it is planned to make certain modifications in the instrument: 1) reduce the number of filters to 12; 2) increase the rate of one spectrum sweep to 1/30 sec.; 3) reduce the velocity of recording to 1/16 sec.; 4) bring the measurement accuracy to 7-8%; 5) change the working altitude to 75 meters. /127

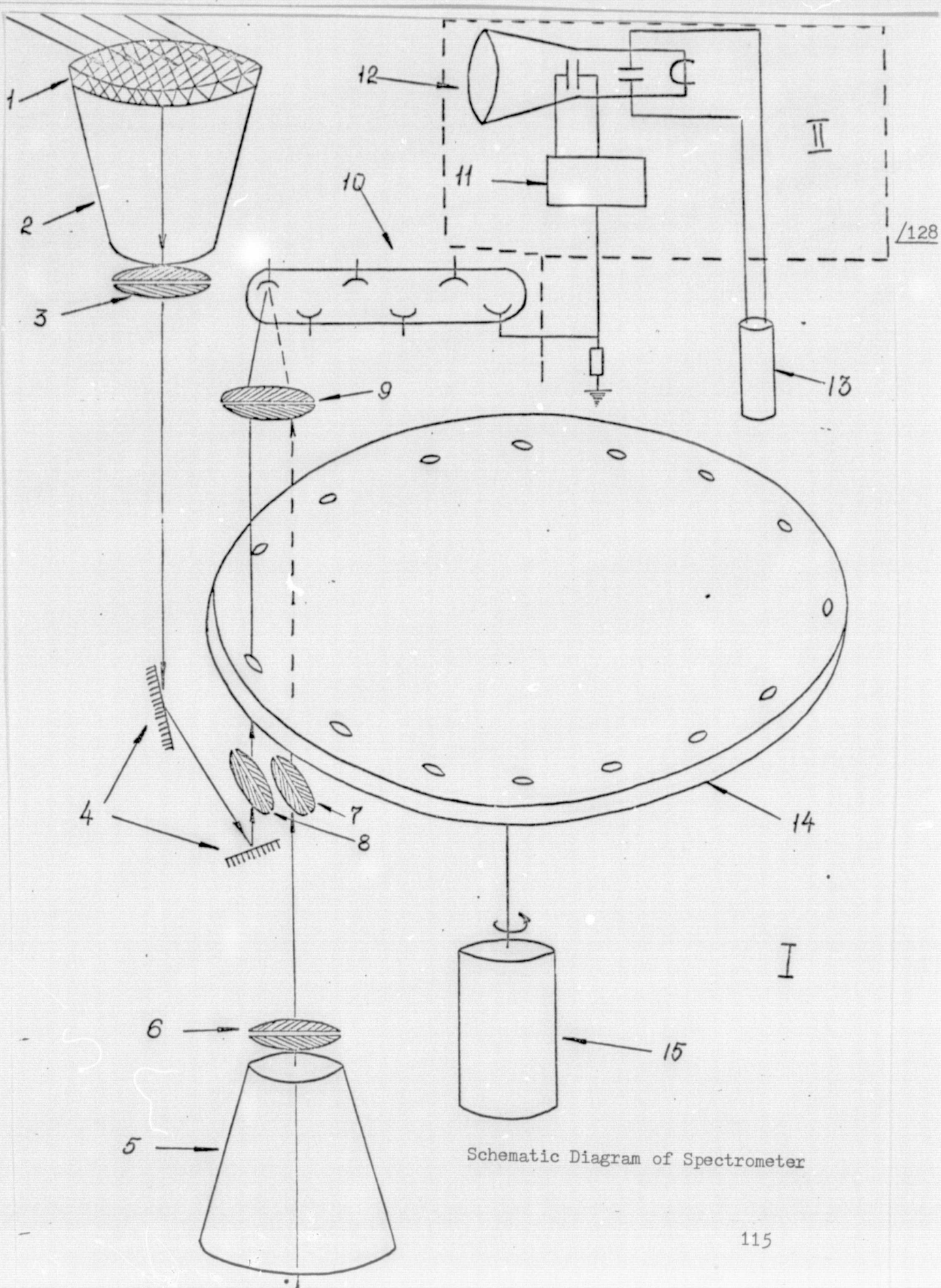
Schematic diagram of spectrometer (fig. 1).

I--extension optic head

1 opal glass (MS13)
2, 5 cap cones
3,6 input lenses
4 flat mirrors
7,8 collimator lenses
9 focusing lens
10 emission receiver (FEU-22)
13 synchronization transmitter
14 disk with interference light filters
15 electric motor

II--recording unit

11 amplifier
12 cathode-ray tube



Schematic Diagram of Spectrometer

Multichannel Airborne Television System /1

Information is given on the airborne multispectrum television system installed in the AN-30 airplane.

1. Characteristics of the system

The television system is designed to produce images of the underlying surface from an aircraft in four spectrum intervals. Scanning of the image by line occurs due to the movement of the scanning mirror, while the image is formed by frame due to the movement of the airplane. The block diagram of the system is given in fig. 1. The television system includes: the on board section consisting of the optical and mechanical unit and the airborne tape recorder, and ground system of reproduction and photographic recording. A block diagram of the on board section is given in fig. 2.

The television system has the following characteristics:
sector of scanning 60°;
momentary angle of vision 2.5 mrad;
horizontal frequency 4 Hz;
working spectrum range 0.5 + 1.1 μm;
output information--negatives.

2. Optical and mechanical unit

The optical and mechanical unit is the basic part of the television system. It implements scanning of the image, forms the synchronization signal and energy calibration. The optic plan of the instrument is given in fig. 3. A kinematic plan is shown in fig. 4. Spectrum characteristics of the channels are given in fig. 5.

3. System of multichannel frequency-modulated magnetic recording

The system of magnetic recording has been created on the basis of an airborne multichannel tape recorder. The system has the following characteristics:

number of channels--fm --15 /2

number of channels--am--1

frequency bands for each channel--0-5 kHz

ratio of v/w in channel--40 db

working rate of tape movement--25 cm/sec

width of magnetic tape--25.4 mm

cassete capacity--750 m

4. Ground system of reproduction

The ground system consists of:

ground tape recorder,

phototelegraphic apparatus.

/3

Figure 1.

1--Optical and mechanical unit; 2--System of magnetic recording (fm); 3--Ground system of reproduction and photographic recording.

/4

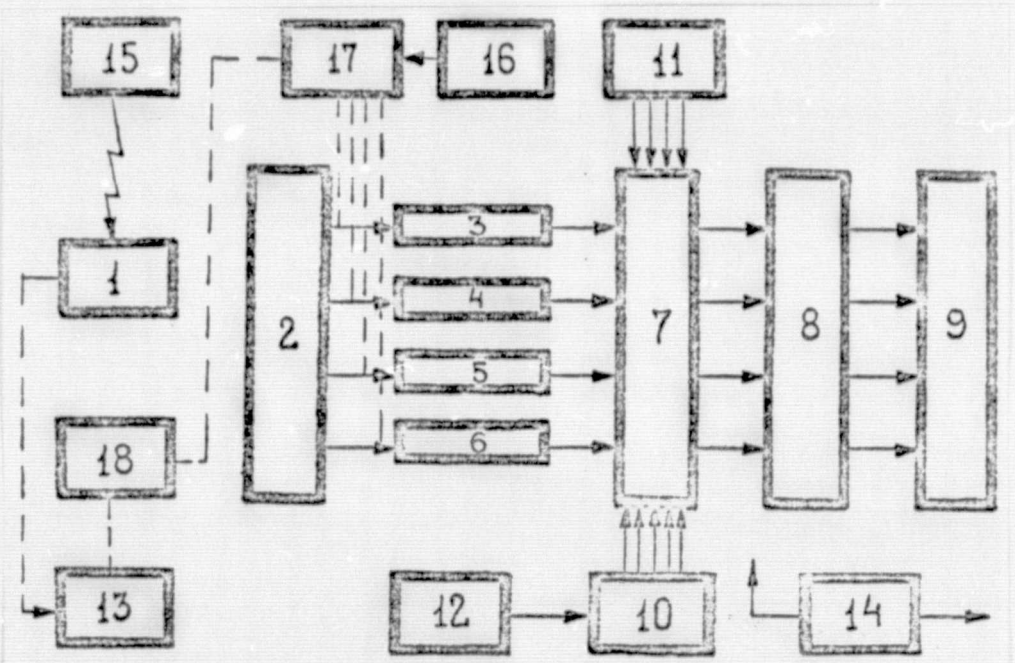


Figure 2. Block diagram of television system
1--scanning mirror; 2--dispersing system; 3,4,5,6--receivers; 7--four-channel video amplifier; 8--output filters; 9--tape recorder; 10--unit of controlled clamping; 11--video signal simulator; 12--generator of cadence signals; 13--scanning motor; 14--power pack of television system; 16--calibration by incandescent lamp; 17--calibrating key; 15--calibration by sun; 18--reducer.

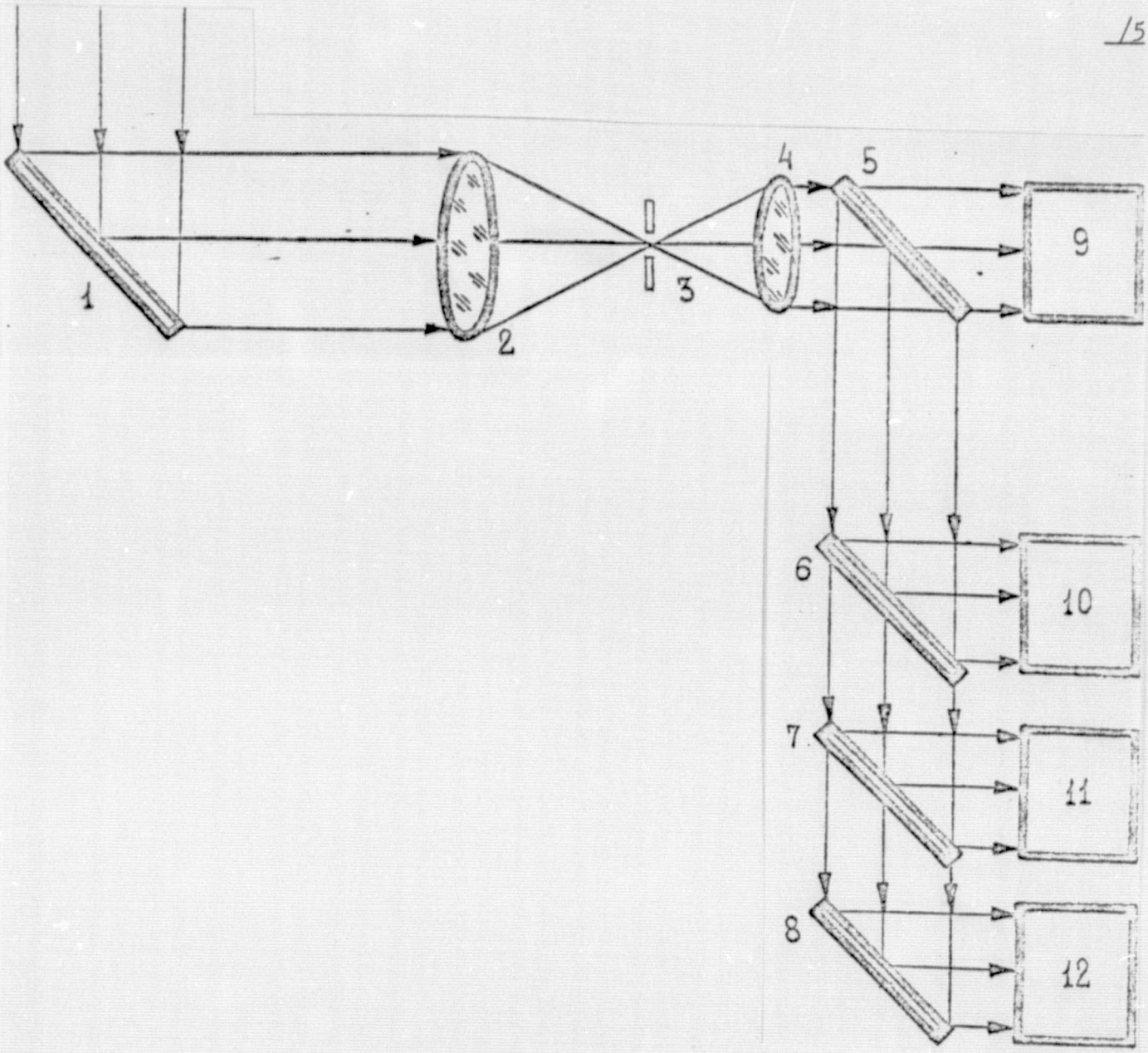


Figure 3. Optic Plan of Instrument

1--scanning mirror; 2--lens (OKS-75); 3--stop aperture; 4--collimator; 5,6,7--dichroic mirrors; 8--swinging mirror; 9,10,11,12--emission receivers (FEU).

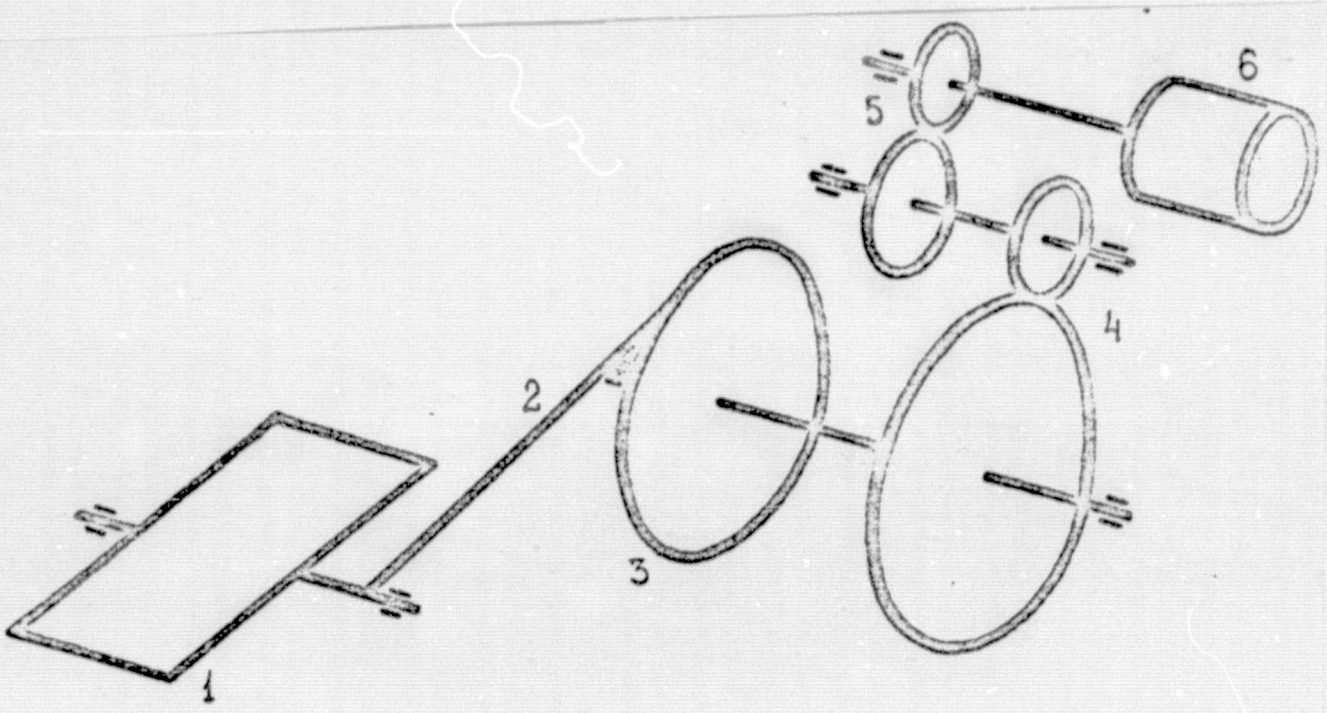


Figure 4. Kinematic Plan of Instrument

1--scanning mirror; 2--rocker arm; 3--cam; 4,5--reducer; 6--electric motor.

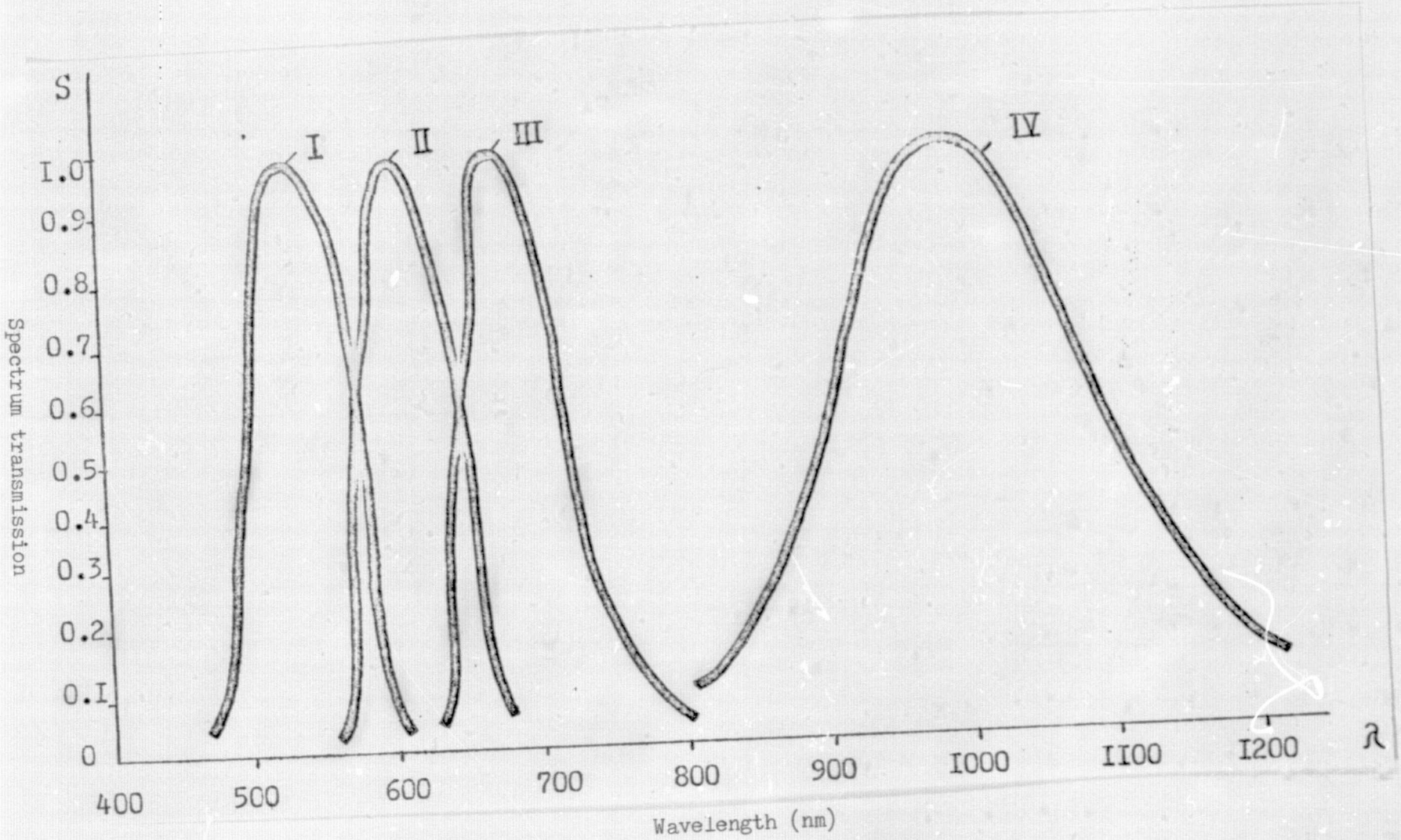


Figure 5. Spectrum Characteristics of Scanner Channels

Multispectrum Airborne Photographic System /1

Data are given which characterize the multispectrum airborne photographic system (camera, airplane trap doors, optic filters, camera lenses, film).

1. Camera

The multispectrum photographic system includes four cameras of model A-39 controlled from one command instrument. The cameras are rigidly installed on one frame in trap door No. 3 of airplane AN-30. The lense "Uran-27" has focal distance 100 mm, f-number 1:2.5, frame format 70 x 80 mm. The shutter type is focal-plane, shutter speeds 1:100, 1:200, 1:300 sec., efficiency of shutter is 55%. The film size is 8 x 1900 cm, the cassete capacity is 19 meters.

2. Airplane trap door

All the apparatus of the system is installed in one trap door of size 600 x 600 mm. Fig. 1 shows the location of the cameras in the trap door of the AN-30 airplane. The spectrum transmission of the trap door glass of the AN-30 airplane is shown in fig. 2.

3. Camera filters

The spectrum intervals are separated with the help of filters. The spectrum transmission of the filters is shown in fig. 3-6 (measurements made 22.03.76). The spectrum intervals, filters and type of film used are given in table 1.

4. Lenses

The spectrum transmission of the camera lenses is shown in fig. 7-8.

5. Film

Isopanchromatic T-17 (apparatus 1-3) and infrachromatic I-840 (apparatus 4). Spectrum sensitivity of the films is shown in fig. 9.

TABLE 1 /2

COMBINATION "FILM-FILTER" AND SPECTRUM RANGES

Number of camera	Film	Filter	Spectrum ranges (micrometers)
1	T-17	Blue	0.40-0.48
2	T-17	Green	0.49-0.60
3	T-17	Red	0.61-0.72
4	I-840	Infrared	0.71-0.80

Direction of flight /3

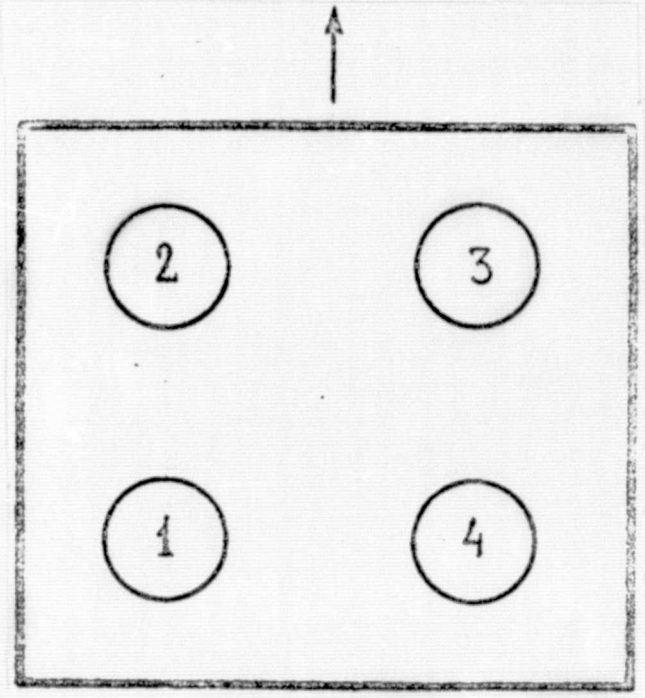


Fig. 1. Location of Aerial Cameras in Trap Door of AN-30 Airplane

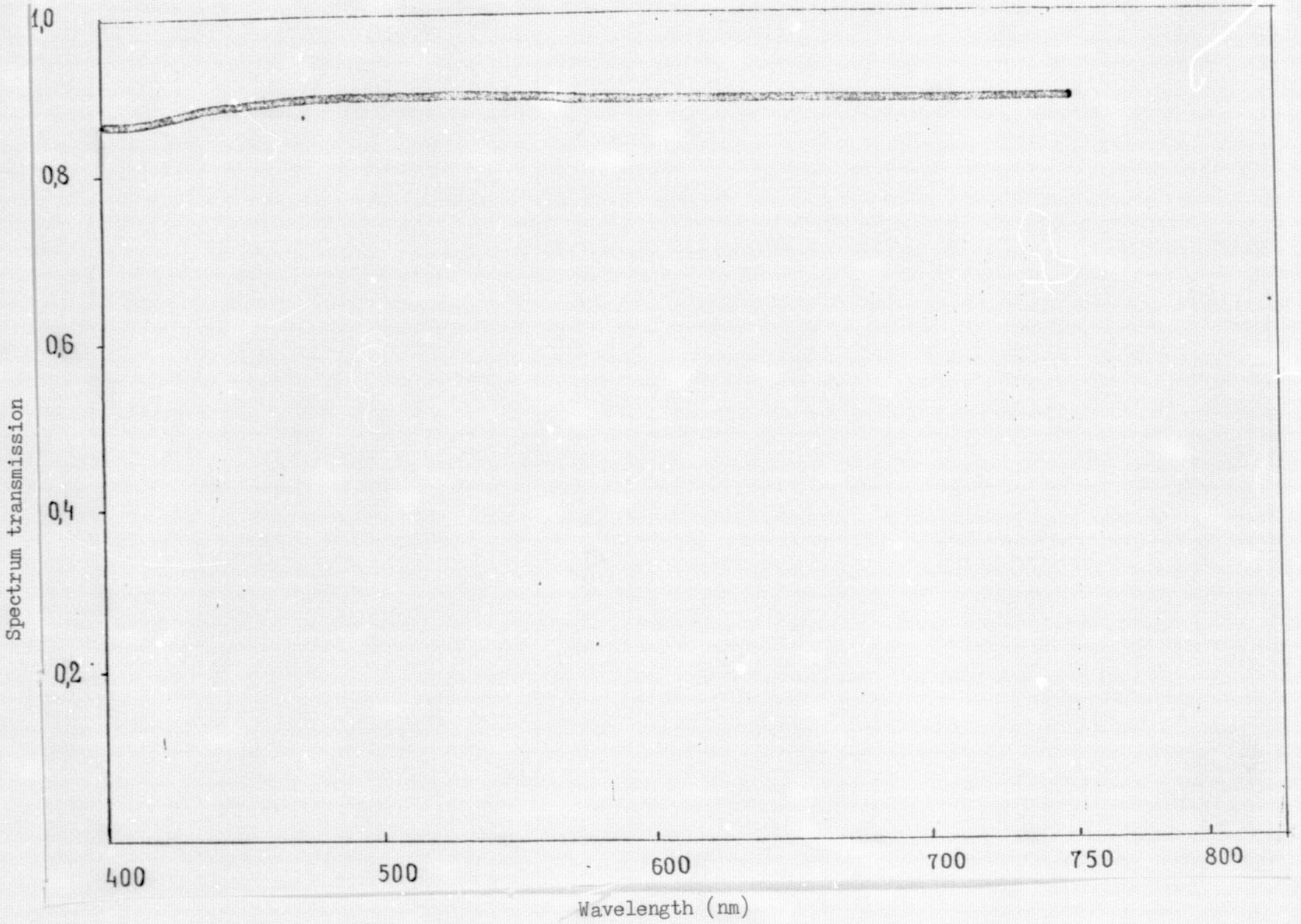


Fig. 2. Spectrum Transmission of Trap Door Glass of AN-30P

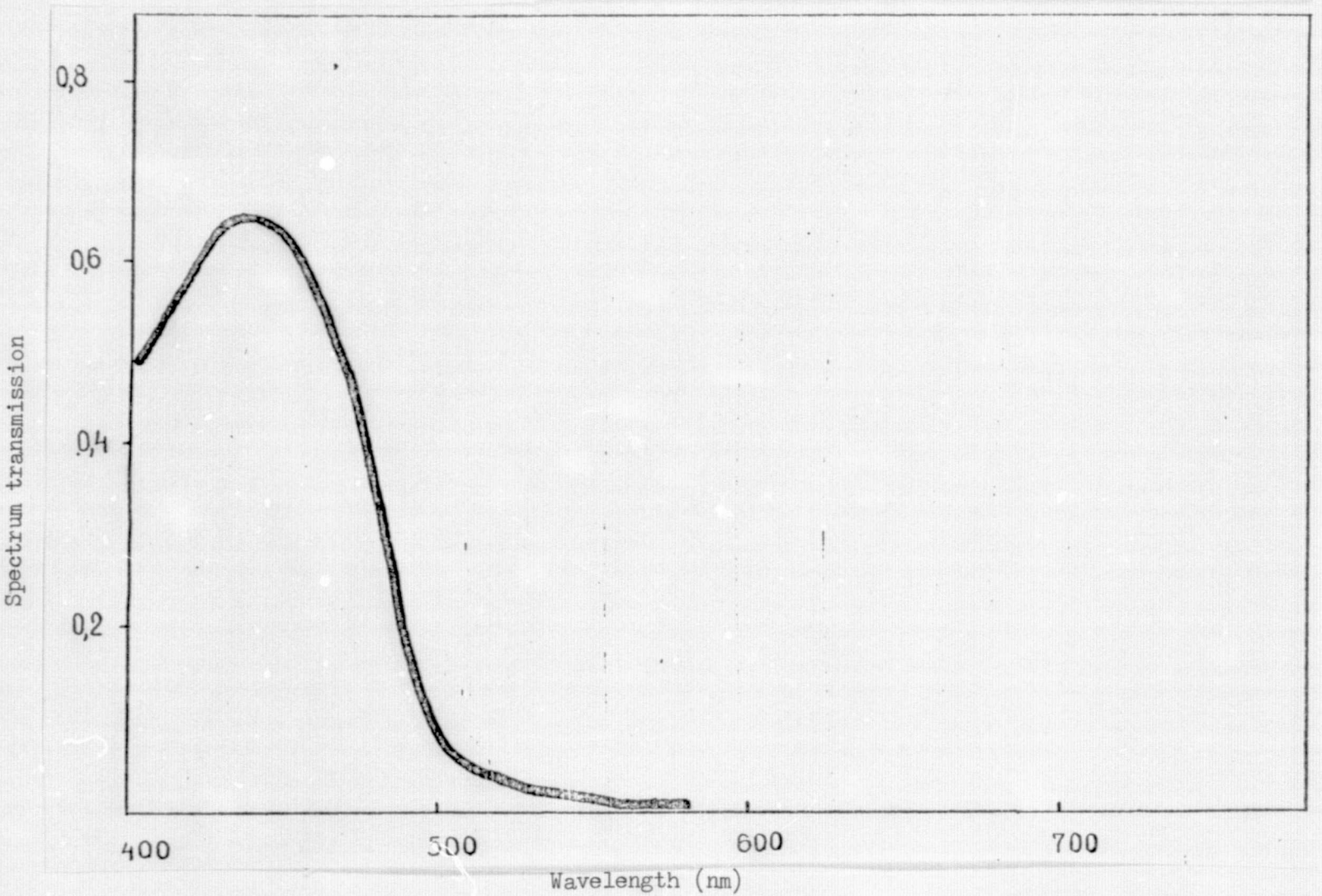


Fig. 3. Spectrum Characteristics of Filter in Camera 1 Measured 22.03.76

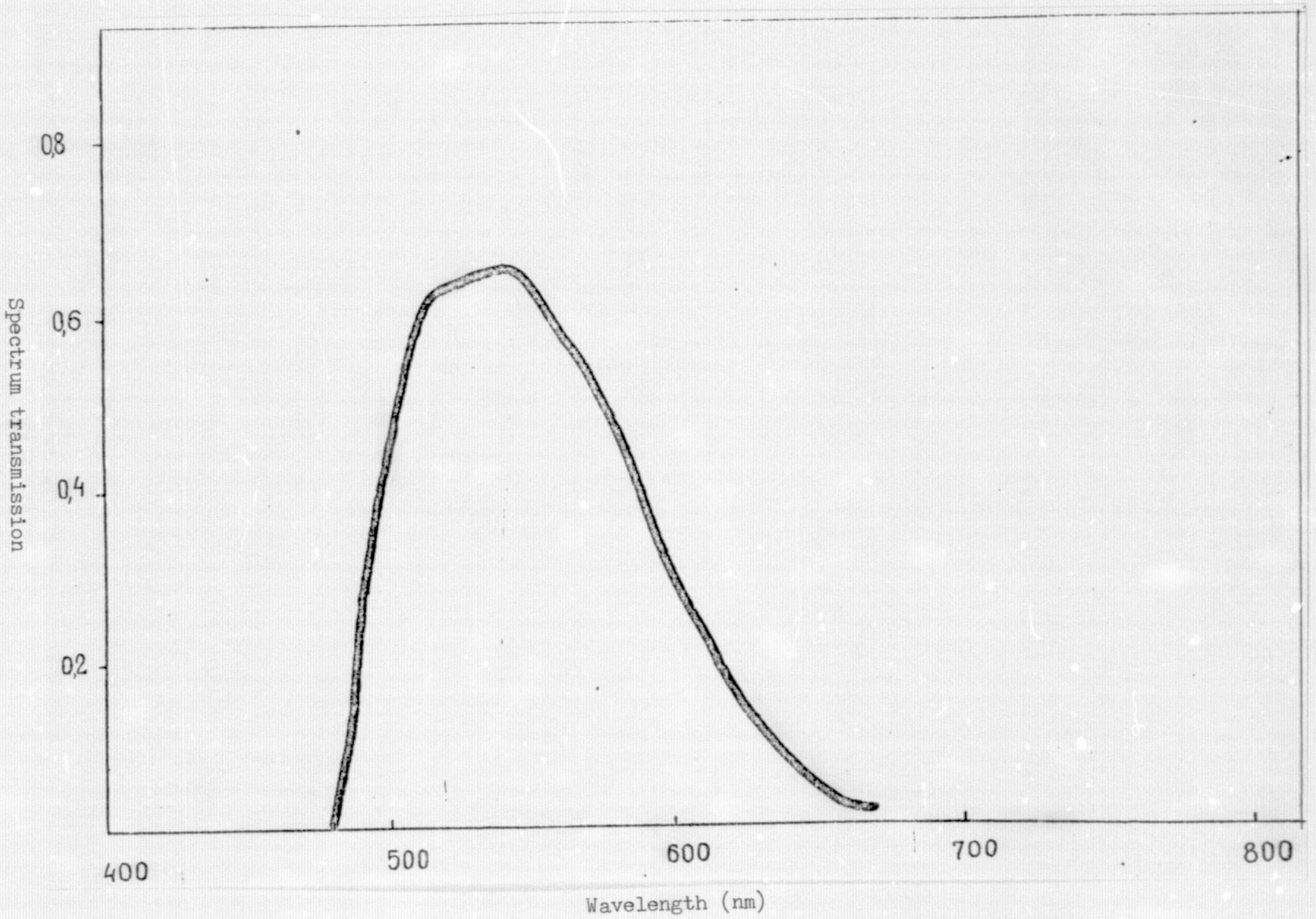


Fig. 4. Spectrum Characteristics of Filter in Camera 2 Measured 22.03.76

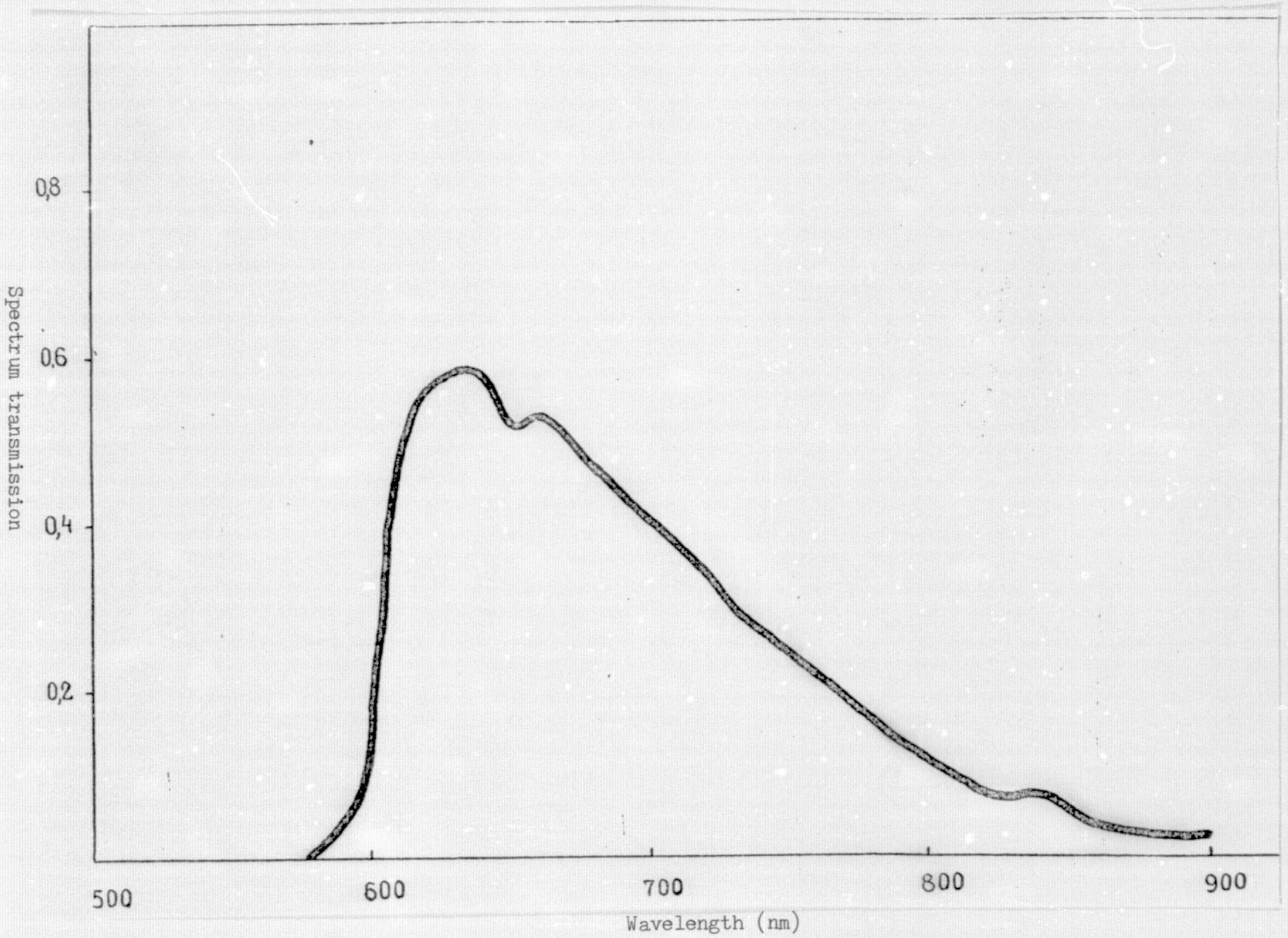


Fig. 5. Spectrum Characteristics of Filter in Camera 3 Measured 22.03.76

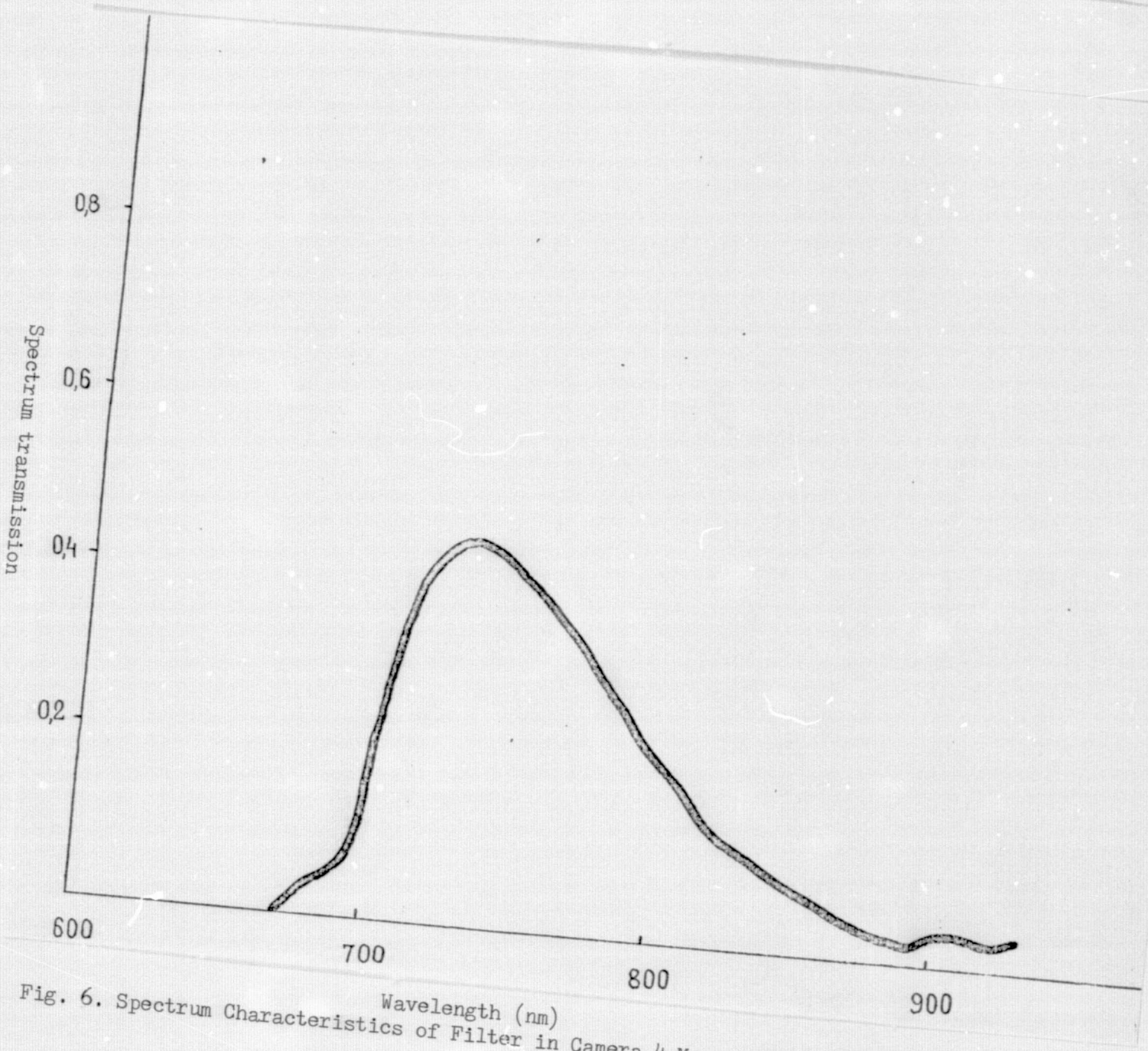


Fig. 6. Spectrum Characteristics of Filter in Camera 4 Measured 22.03.76

/8

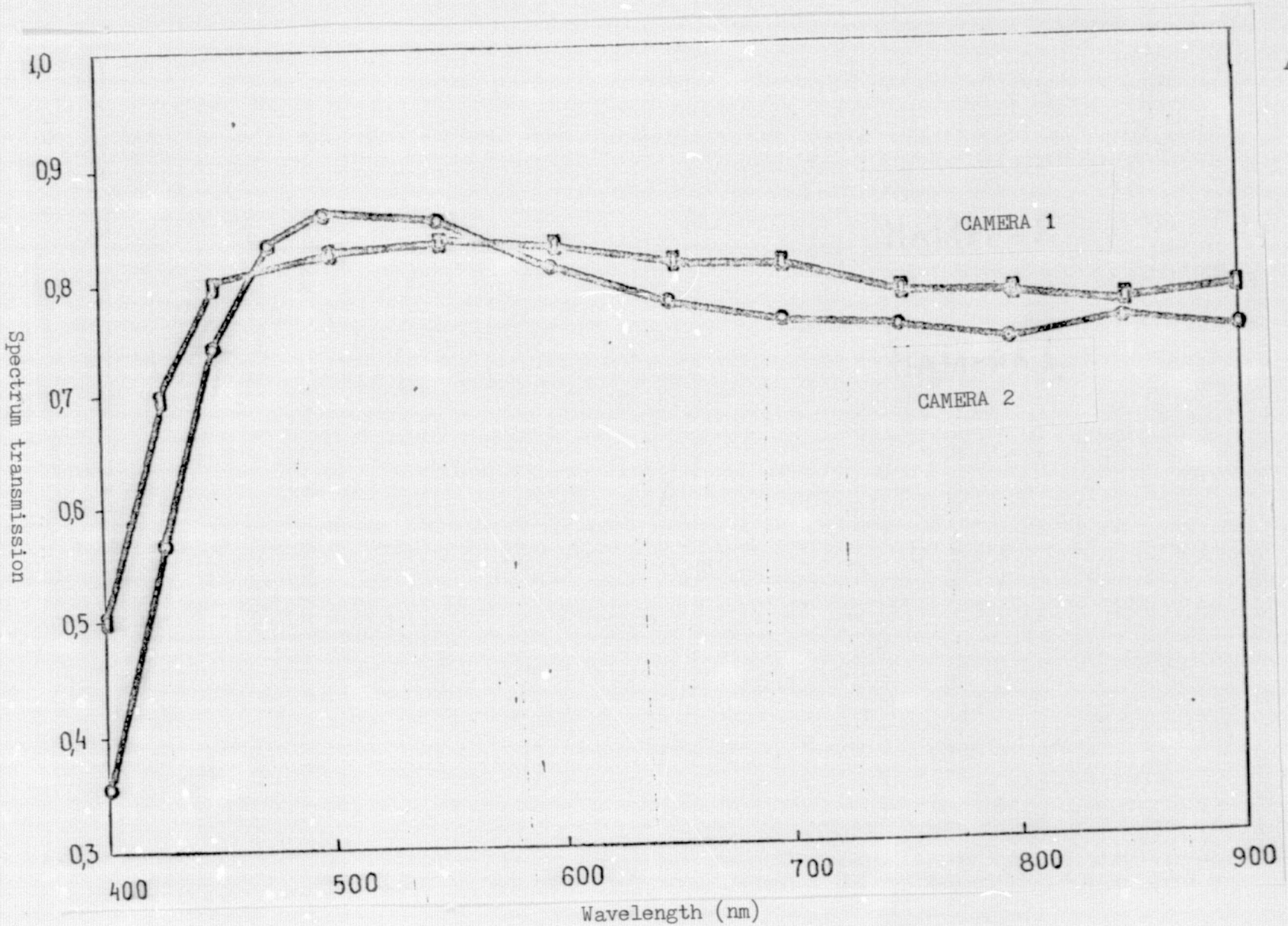


Fig. 7. Spectrum Transmission of Lenses in Camera 1 and 2

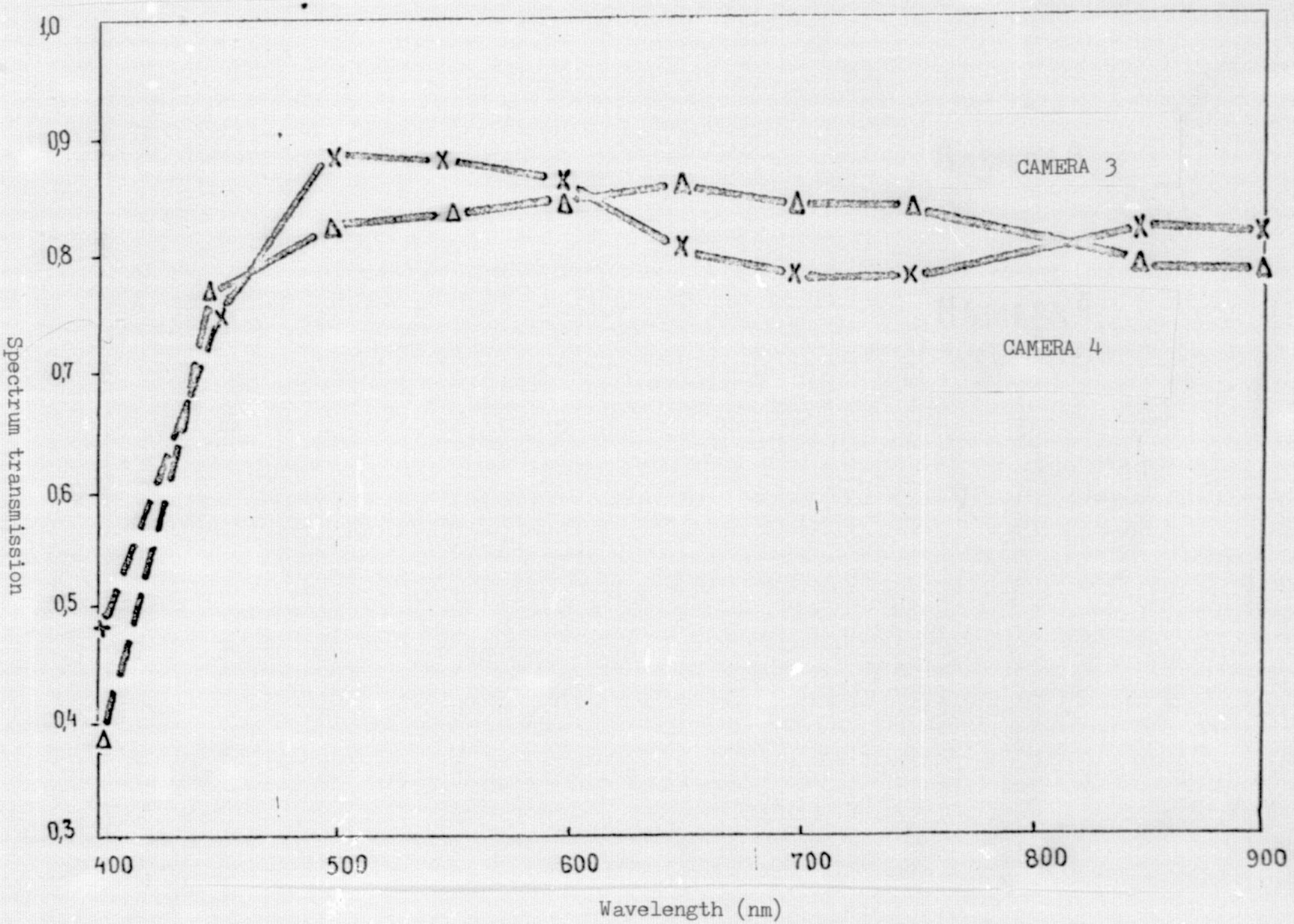


Fig. 8. Spectrum Transmission of Lenses in Camera 3 and 4

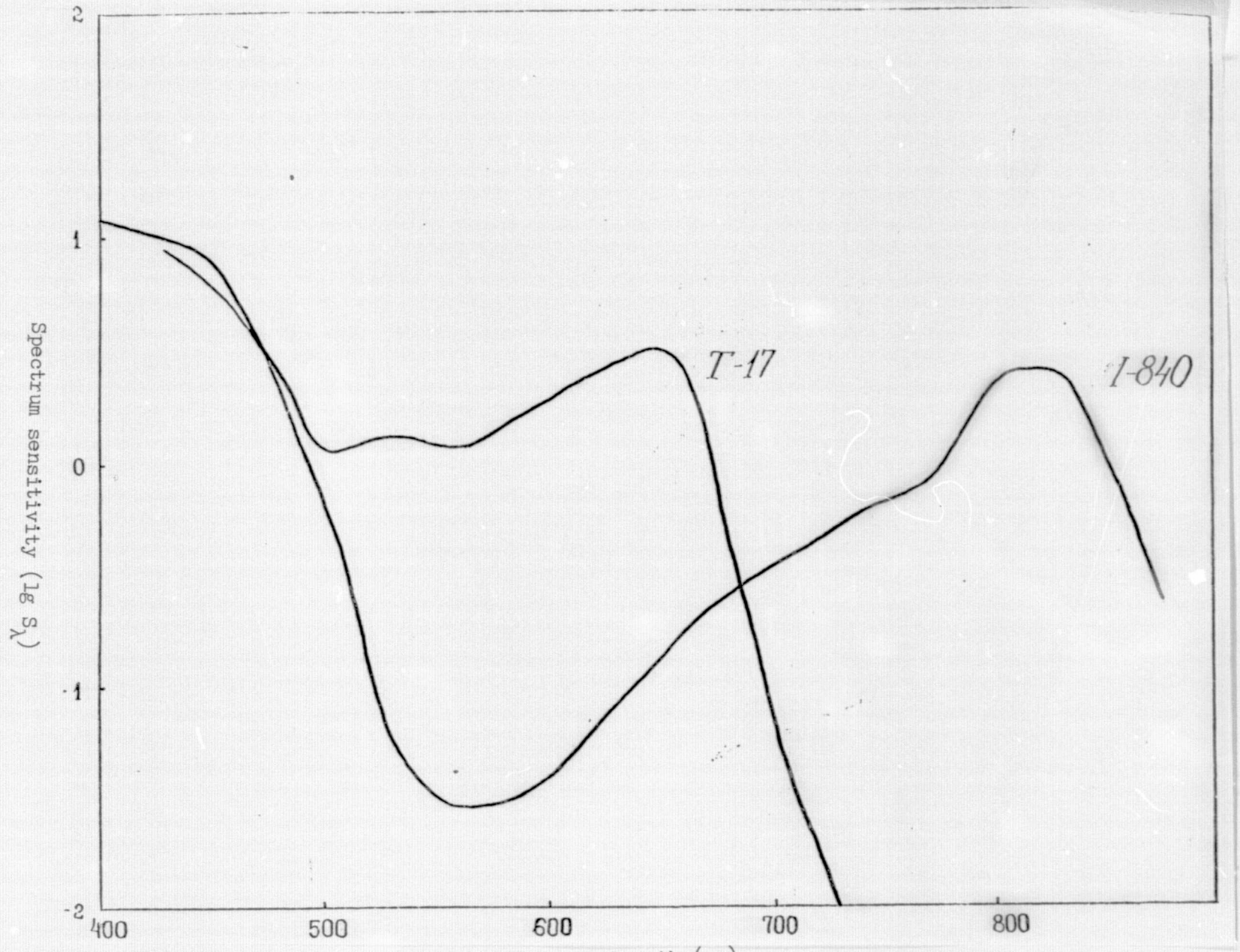


Fig. 9. Curves for Spectral Sensitivity of Aerial Film TIP-17 and I-840